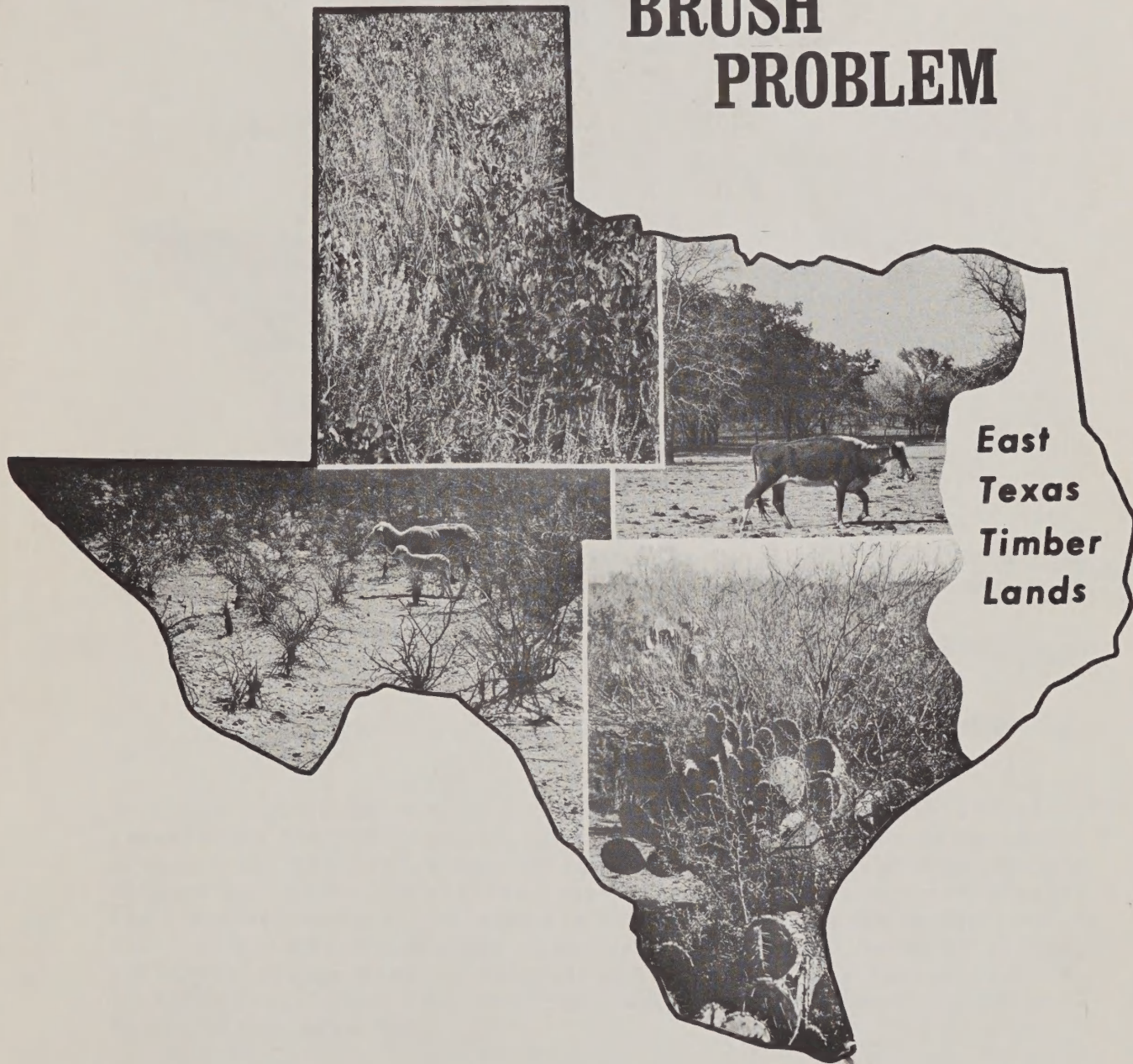


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Grassland Restoration **THE TEXAS BRUSH PROBLEM**



UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE - TEMPLE, TEXAS - JUNE 1964
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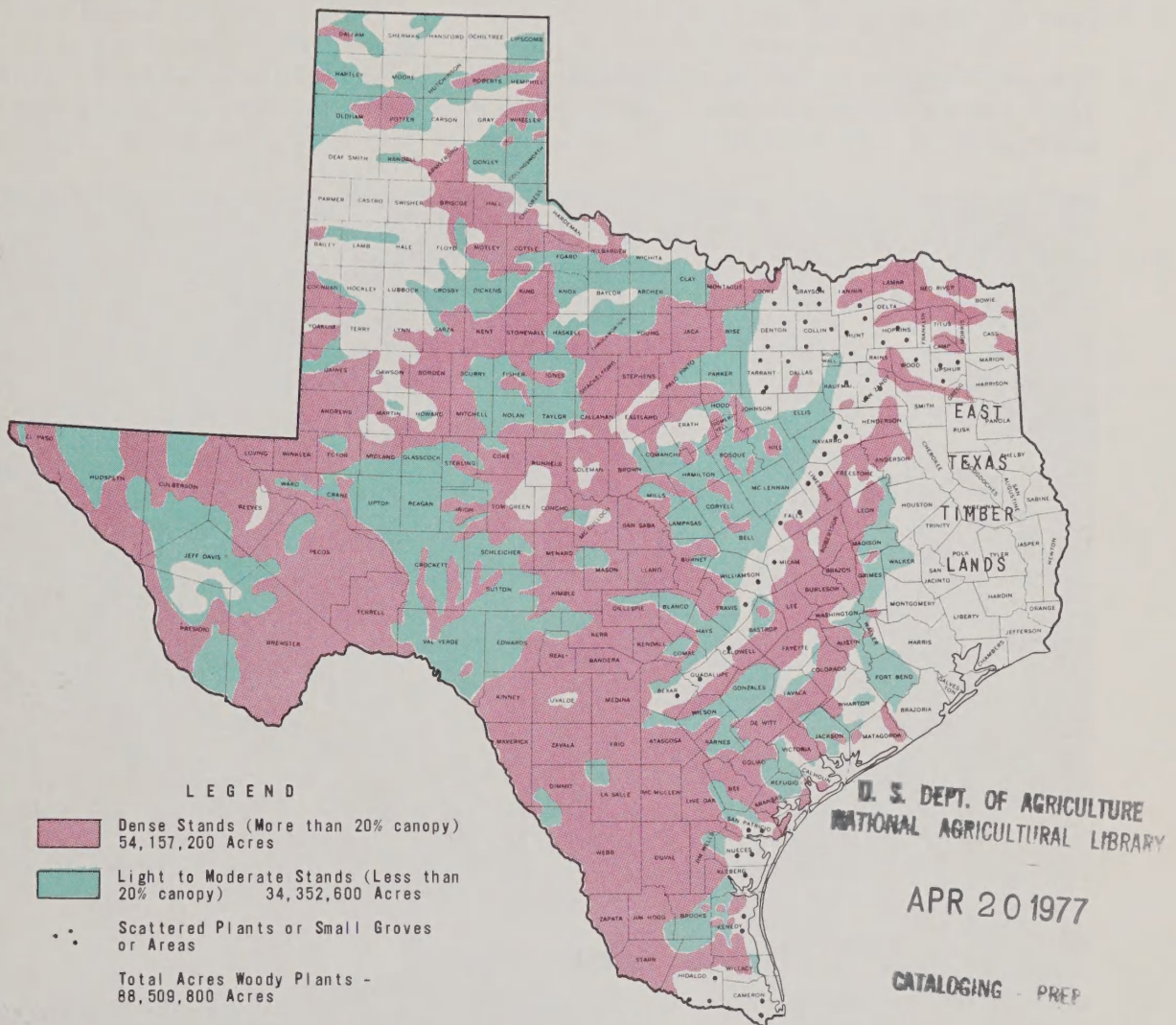
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GRASSLAND RESTORATION - - THE PROBLEM.....

H. N. SMITH, STATE CONSERVATIONIST, AND C. A. RECHENTHIN, SOIL CONSERVATIONIST
SOIL CONSERVATION SERVICE, TEMPLE, TEXAS



Brush is the number one problem on Texas grasslands. This fact is revealed by the 1963 resurvey of the brush problem by range conservationists of the Soil Conservation Service, and illustrated by the colored map above. Worthless brush is slowly and surely suffocating the livestock industry in Texas and the Southwest by robbing ranchers of their soil, water, and plant resources. Millions of acres of grazing lands are now so heavily infested with woody plants that production of nutritious forage is greatly reduced, making the range unprofitable for livestock grazing.

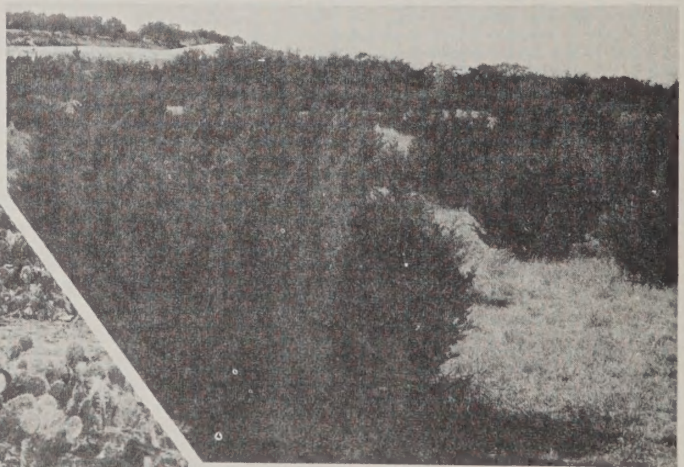
The survey shows that 88.5 million acres, or 82 percent, of Texas' once luxuriant grasslands are now infested with one or more low-value or worthless woody plants. Fifty-four million, or 50 percent, are so densely covered and the grass so suppressed that little improvement can be expected without reduction of the brush competition. The map above shows total infestation of woody plants excluding, of course, lumber trees.

Furthermore, the brush is increasing in spite of extensive control efforts. In the last 15 years, mesquite, one of the most widespread and troublesome species, has increased by 1.25 million acres. It now covers more than 56 million acres in Texas, and is growing denser year after year on infested land.

The picture below shows rangeland on which "Uncle Bob" Mims of Water Valley once could see every animal on the ranch. Note the young mesquites.



Junipers, called "cedars", have increased by 3.5 million acres in 15 years, and now infest more than 21.5 million acres.



Cactus, that symbol of the desert, occurs on more than 35 million acres in spite of extensive control measures in the last 30 years.

Huisache and retama, introduced as ornamentals, have escaped and spread to more than 2.5 million acres. Macartney rose, introduced as a hedge planting to the Gulf Coast region about 1870, now occupies about 275,000 acres, an increase of over 230,000 acres in the last 15 years. Whitebrush, lotebush, and yaupon are other species making rapid increases on Texas grasslands. Saltcedar, introduced as an ornamental in the mid 1800's, now is established on more than one-half million acres along Texas water courses and is stealing water at a rate estimated at one and one-half to two acre feet per acre annually from streams and reservoirs.

The increase of worthless brush is a problem of growing concern to livestock men and conservationists. Less than 25 percent of the grasslands now have as much as half of the good forage plants that made Texas the great livestock producing state that it has been. It is estimated that 30 to 35 percent have less than one fourth of the original good forage plants remaining. A range in the condition of the one here pictured just isn't yielding enough forage for profitable livestock production!



Livestock operators cannot afford grasslands in poor condition. A poor condition range, having less than 25 percent of the good forage plants, is a "sick" range. So little high quality forage is being produced that it isn't paying its way. High feed bills, death losses, and low gains are robbing the rancher of most or all of his profits.

Brush, which is nearly always present on poor condition grasslands, not only is occupying land that should be growing grass but is also stealing the rancher's soil and water resources. Brush plants have

tremendous root systems, as shown in the picture, and are usually water hogs.



Research in Arizona showed that mesquite trees use about 1,725 pounds of water to grow one pound of dry matter and catclaw about 2,400 pounds of water. On the other hand, sideoats grama, one of Texas' most widespread and better forage grasses, uses only about 705 pounds of water per pound of dry matter, Arizona cottontop about 547, and blue grama about 596 pounds.

It has been estimated that brush, cacti, and weeds in Texas use about 146 million acre-feet of water annually, or 40 percent of the state's total use. That water is a vital asset that neither the ranchers nor downstream water users can afford to lose.

Brushy ranges are nearly always in a drought condition because the more vigorous brush is using most of the water that gets into the soil to the detriment of grass and other good range plants.

GRASS TO BRUSH.....

Explorers and early white settlers found broad expanses of luxuriant grass that many considered to be "unlimited" grazing resources. Descriptions of Texas grasslands date back to the 1600's and 1700's when Spanish explorers repeatedly mention the abundant grazing that was available. The first settlers in the Austin colony on the lower Colorado and Brazos Rivers wrote home that grass grew belly-deep to a cow, and that livestock grew with amazing rapidity both in weight and numbers. Traders and hunters returned from the plains of West Texas with tales of vast grass plains on which thrived millions of buffaloes.



Nearly all the early travelers and writers mention scattered trees, or mottes and bands of trees and other woody growth along the watercourses or rocky and gravelly hills. Mesquite and other woody plants were undoubtedly present in minor amounts, and producing seed which, given a chance, would surely spread over the grasslands.

It was to this land of "unlimited" grass that the white man brought his herds and flocks. The opening of Texas to settlement by Americans in 1820, its subsequent fight for freedom from Mexico, and annexation to the United States in 1845 started an immigration surge that didn't stop until the entire state was occupied. Always out on the frontier were the livestock men and their herds. By 1880, almost the entire range area of the state was being grazed and some was already being heavily used. There are records showing that as many as three hundred animals were grazed on a section in Central West Texas, and an animal to five acres or less on the Gulf Coast.

Heavy use of the grass, intensified by drought, has caused an almost unbelievable change in the natural vegetation. Most of the undesirable woody plants are adapted to dry climates and sparse cover. When the grass was removed by grazing and drought, the seed of the woody plants were able to germinate and get established. The result has been a "population explosion" of the undesirable species when they were given an opportunity to spread.

A bare range is ideal for the spread of unpalatable woody and weedy invaders. This range was once open rangeland with only a few scattered trees.



There isn't much palatable forage produced on a brush-infested range like this. This is typical of much of the "Brush Country" of South Texas.

EXTENT AND SEVERITY OF THE BRUSH PROBLEM.....

The Soil Conservation Service in Texas made a survey in the fall and winter of 1963 to determine extent and severity of the brush problem. The survey was a follow-up of the 1948 survey, results of which were reported in SCS publication, DISTRIBUTION AND CONTROL OF SEVERAL WOODY SPECIES IN THE WESTERN GULF REGION, by B. W. Allred. The two surveys give a startling insight into the brush problem in Texas.

The 1963 data are shown in tables 1 and 2. Maps showing extent and severity of the more important species in Texas are included in the appendix.

Table 1. SUMMARY OF BRUSH SURVEY BY LAND RESOURCE AREAS

Land Resource Area	Total Ac. Grassland & Non-Comm. Forests*	Brush Infestation				% of Land Infested
		Light (Less than 10% Canopy)	Medium (10 to 20% Canopy)	Thick (More than 20% Canopy)	Total Acres	
High Plains	6,483,500	609,200	1,378,500	2,737,800	4,725,500	73%
Rolling Plains	17,035,000	2,003,700	4,673,100	8,259,100	14,935,900	81
North Central Prairie	4,390,800	353,900	470,400	2,950,300	3,774,600	86
Cross Timbers	1,875,600	26,900	105,300	569,000	701,200	37
Edwards Plateau	22,288,100	1,563,300	9,050,400	10,968,900	21,582,600	97
Trans-Pecos	16,762,000	1,927,000	3,499,000	9,731,300	15,157,300	90
Rio Grande Plain	16,974,500	1,298,400	2,063,100	12,419,200	15,780,700	93
Central Basin	1,206,600	3,200	298,500	848,200	1,149,900	95
Blacklands	4,419,500**	609,500	921,900	1,816,500	3,347,900	76
East Texas Timberlands	7,988,700**	764,100	887,900	4,329,500	5,981,500	75
Coast Prairie	3,229,300**	272,900	180,700	572,600	1,026,200	34
Grand Prairie	4,478,300**	771,200	620,500	1,689,800	3,081,500	69
State Total	107,131,900	10,203,300	24,149,300	54,157,200	88,509,800	82%
Percent		9%	23%	50%	82%	

*Data from Texas Conservation Needs Inventory

**Includes 518,700 acres Bottomlands

Table 1 shows that the greatest brush problem exists in the Rio Grande Plain, Edwards Plateau, Central Basin, and Trans-Pecos areas, all with more than 90 percent of the grasslands infested with brush. The Rio Grande Plain data are quite significant in showing that more than 12 million acres are densely infested. No wonder the area is commonly referred to as "The Brush Country"!

Table 2. SUMMARY OF BRUSH SURVEY BY IMPORTANT SPECIES

Species	Acres in Each Density Class			Total Acres
	Light (Less than 10% Canopy)	Medium (10 to 20% Canopy)	Thick (More than 20% Canopy)	
All Woody Plants	10,203,300	24,149,300	54,157,200	88,509,800
Mesquite	22,094,900	18,337,100	15,812,800	56,244,800
Huisache and Retama	1,877,400	592,800	164,600	2,634,800
Junipers - Eastern Red, Blueberry, Redberry	9,813,100	8,305,900	3,392,500	21,511,500
Post and Blackjack Oak	3,045,200	2,453,400	5,803,000	11,301,600
Cactus - Pricklypear, Cholla, Tasajillo	27,200,700	6,173,600	2,378,600	35,752,900
Whitebrush	3,557,600	1,633,800	853,900	6,045,300
Blackbrush Acacia	3,618,100	3,975,800	1,020,700	8,614,600
Live Oak	8,084,900	6,134,600	1,821,200	16,040,700
Shin Oak	4,462,300	1,842,000	2,426,900	8,731,200
Guajillo	2,955,100	1,971,900	1,470,700	6,397,700
Sand Sagebrush	2,829,200	1,574,000	701,800	5,105,000
Saltcedar	117,600	133,300	273,000	523,900
Yaupon	839,200	742,000	1,043,200	2,624,400
Elm	1,558,700	347,000	646,500	2,552,200
Persimmon and Sassafras	252,000	128,200	22,000	402,200
Macartney Rose	160,000	70,700	44,900	275,600

The immensity of the problem is clearly revealed in the two tables. Woody species infest 88.5 million acres, or 82 percent, of the state's grasslands. Half of the grassland, 54 million acres, has dense stands which will require major and costly control measures to restore productivity. The map on page 1 shows that the densely infested areas are widespread over the state except on the Gulf Coast. The large extent of dense infestation emphasizes the importance of action to control undesirable woody species because they are still spreading and the problem is rapidly becoming worse.

Comparing 1963 data for some of the individual species with the 1948 data gives an insight into the spread that is occurring. However, since no estimate was made in 1948 regarding the total infestation, it is not possible to make a comparison in this acreage.

Table 2 shows that mesquite is the most common and widely spread "pest" plant in Texas. About 52 percent of the grasslands of the state are infested with mesquite, of which almost 16 million acres, 15 percent of the state total, are so densely covered as to suppress grass production seriously. There has been an increase of 1.25 million acres in the last 15 years, as well as thickening of the stand on land already infested. Mesquite now occurs over the entire state, and has spread as far north as Kansas.

Mesquite is a prolific seed producer, and livestock and wild animals relish the ripe beans. A peculiarity of mesquite is that the seed germinate more readily when they have passed through the digestive system of livestock, and thus are spread over wide areas. They readily become established when falling on bare or denuded ranges.



Twenty years ago this range near Ballinger was an open grassland with scattered mesquites. The old trees have produced the seed from which a host of young trees are turning this formerly productive grassland into a thicket of mesquite.

The junipers have made an amazing spread -- more than 3.5 million acres since 1948. There are three species that have become pests - redberry, which is most common in West Texas; blueberry (also called "post cedar" because of its use for this purpose), found mostly on the limestone soils of the Edwards Plateau and Grand Prairie; and eastern redcedar, common in the post oak strip of the eastern part of the state. The fleshy fruit of the junipers is relished by many birds and some wild animals such as 'possums, rabbits, and foxes. Seeds pass through the digestive system of the birds and animals without being digested, and become an important means of spreading the plants.



Junipers produce such dense shade that grass is almost eliminated in the "Cedar brakes". Dense cedar is a poor wildlife habitat as well as poor livestock country.

There are 76 species of cacti in Texas, but only five of them have become problems of any magnitude. They occupy more than 35 million acres



and grow everywhere except in the "Piney Woods" of East Texas. Texas pricklypear, common in the southern half of the state, grows in large clumps sometimes 40 feet or more across, and six to eight feet high, forming dense, impenetrable thickets. It is often used as an emergency feed after burning the spines. It has saved many a rancher on drought-stricken, heavily used ranges, but the fact remains that the pricklypear is using soil and water resources that could be more efficiently used to produce forage of higher quality.

Engelmann and plains pricklypear are smaller species found mostly in western and northwestern Texas. Tasajillo, also called "jumping cactus" because the small branches fly off when the plant is touched, and "turkey cactus" because turkeys are fond of the red, berry-like fruit, is often found in dense stands in Central and South Texas. Cholla is a larger, round-stemmed cactus that is common in West Texas, sometimes forming "forests" in valleys of the Trans-Pecos area.

Cacti spread rapidly on grasslands in low condition or with sparse cover because the pads or branches, and seed that have passed through birds and animals, can readily become established on bare ground. Although eradication has been attempted on millions of acres, reinfestation too often occurs within a few years. Cactus has become troublesome on land where other brush has been controlled by mechanical means.

The oaks - live, post, and blackjack - are natural components of a savannah vegetation that characterizes a large part of Central and East

Texas. Live oak covers more than 16 million acres, and a mixture of post and blackjack oak more than 11 million. The three species have little commercial value for lumber or posts, and the land is better suited for livestock grazing. Reduction of the grass cover, fire, and drought have permitted the oaks and an understory of associated woody species to thicken in stand. Over 7.5 million acres are now densely covered. Even though the leaves of the oaks have some browse value, and the acorns are excellent wildlife food, a dense stand of trees produces little useful forage.

More than 8.5 million acres are covered with shin oak, or "shinery", with 2.5 million in dense stands as on the right of the fence. The shin oaks occur primarily in the Cross Timbers, on the sandy soils of the Rolling and High Plains, and rocky soils of the Edwards Plateau. Although the leaves are good browse, a dense stand of shin oak produces little usable forage. The shin oaks are deciduous, leaving poor browse in winter. The buds in spring may also cause "shin oak poisoning".



Sand sagebrush is characteristic of deep sands of Northwest and West Texas, often associated with shin oak. It has some browse value, but like shin oak, is poor grazing when in dense stands. More than five million acres grow sagebrush, with 700,000 acres in dense stands.

Huisache and retama were introduced as ornamentals and shade trees into Texas in pioneer times. They have escaped into grasslands and are spreading rapidly in South Texas, now covering more than 2.5 million acres. Macartney rose is another introduced plant, brought in for a hedge planting about 1870. It has escaped and is rapidly spreading, and has been found rather difficult to control. It is now found on 275,000 acres, an increase of 230,000 acres since 1948.

Whitebrush is a native of southern Texas where it once occupied lowlands as an inconspicuous shrub. It is commonly called "beebrush", because the white fragrant flowers which it puts out soon after a rain attract great numbers of bees. The honey produced is quite tasty, and a favorite of many people. Unfortunately, the plant spreads rapidly from both seed and root sprouts when the natural grass cover is reduced. It forms dense colonies that shade out the grass. Whitebrush has become a pest in the area immediately south of the Balcones Escarpment, in the valleys of the Edwards Plateau, and in the Central Basin, where more than six million acres are infested.

Guajillo is abundant in the hills of the Southwestern Edwards Plateau, and in the Rio Grande Plain. It is a good browse plant, but when the grass is depleted, the shrub thickens until the vegetation may consist of almost pure stands. Sheep on a diet of guajillo alone sometimes suffer from "guajillo poisoning". Guajillo is a useful browse plant; it

should be reduced in stands, where excessive, rather than eliminated. Almost 1.5 million acres of the six million acres where this plant occurs are covered by dense stands where control is needed.

Saltcedar is an Old World plant brought to this country for use as windbreak, shade, and ornamental. It has now escaped to become an important pest along streams and reservoirs and in the irrigated areas of West Texas. It is a costly invader in that it transpires and wastes immense amounts of water each year. Saltcedar occupies more than a half million acres, and is rapidly spreading.

Yaupon and winged elm, each found on about 2.5 million acres of East Texas grasslands, have become serious problems. Common persimmon and sassafras are spreading on formerly cultivated fields and pasturelands and require repeated treatment for control.

Other woody plants that are locally acute problems but which have not been included in the survey are numerous. Creosotebush on 16 million acres, tarbush on 12 million, and lecheguilla are widespread in the Trans-Pecos. Yucca and catclaw acacia are abundant on sandy soils of the High and Rolling Plains. Lotebush is scattered and becoming a problem over wide areas of western and southern Texas. Flameleaf sumac becomes a pest on heavily used, burned over, or brush-treated grasslands in the central part of the state. Coyotillo, a poisonous shrub of Southwest Texas, and many kinds such as granjeno, guayacan, condalias, amargosa, and others constitute the chaparral of South Texas. Texas persimmon, mescalbean (locally called mountain laurel), and other shrubs are local problems in the Edwards Plateau, and the half-shrub, snakeweed, or turpentineweed, is common over large parts of West Texas where it may cause cows to lose their calves.



Grass and better forage plants have a difficult time growing on creosotebush and tarbush infested ranges.

CONTROL OF BRUSH IS AN ESSENTIAL STEP IN GRASSLAND RESTORATION.....

The basic need in bringing Texas' grassland back into high production is to improve or restore the plants that can produce high quality forage most efficiently under Texas conditions. Because of the dominance of brush, range restoration will have to consist of a four-point program - (1) control of undesirable brush, (2) re-establishment of the desirable plants by natural or artificial means, (3) control of sprouts and re-infestation, and (4) management of the grass to maintain the grasslands in high productivity.

Extensive control efforts have already been made. Soil conservation district cooperators, Great Plains Conservation Program producers, and Agricultural Conservation Program participants used brush control measures on more than two million acres in 1963, and about the same in each of the three preceding years. It is estimated that some 30 to 35 million acres have been treated, some of it two or three times. However, on July 1, 1963, Soil Conservation Service technicians estimated that the treatment was still effective on only 15 million acres. The brush was reinfesting treated acres after a few years, requiring repeated treatment for control. Comparing the 1963 survey with the 1948 survey shows that brush actually is gaining in the state.

Effective treatment of brush is a complex and difficult problem, as well as a costly operation. Complete treatment for some thickly infested grasslands to restore productivity, which may include brush control application, raking, burning, seeding, fencing, and other measures, sometimes requires an outlay of \$15 to \$35 an acre. The cost over the state ranges from a low of about \$3 per acre to much more. The cost alone prohibits some operators from carrying out a control program.

A more comprehensive discussion of control methods and costs will be included in a companion publication, GRASSLAND RESTORATION - BRUSH CONTROL. Brush control must be part of a long-term conservation plan that is systematically applied if it is to be effective in restoring the grasslands to their potential productivity.

The second step in range restoration is to improve the stand and productivity of the forage plants once the brush has been controlled. Some grasslands have enough of the desirable forage plants left to make needed improvement if the grass is given a chance. Most grass on brushland is in low vigor, the result of competing with the brush for sunlight, moisture, and soil nutrients. A rest period following treatment is essential. Other brushland may have so little grass remaining that reseeding of adapted grasses is necessary. Seedbed preparation and price of seed add to the cost. Reseeded areas must be rested for a growing season to permit new seedlings to become established. Deferring grazing following treatment is often the key to successful improvement. Treatment on many acres has been nullified because the grasses were not given a chance following brush control.



Even though the brush has been controlled on these pastures, there is little improvement in forage because of lack of management. More soil and water are being lost than before brush treatment!

Reinfestation must be controlled as the third step in range conservation if lasting benefits are to be realized. Partial control, resprouts, and seed either on the ground or brought in by birds or animals are important sources of reinfestation. There is no treatment presently known that eradicates all the undesirable plants. Complete eradication is generally impossible and impractical; and it is often not desirable because the woody plants may have considerable value as wildlife food and cover plants.



Mottes of trees have been left on the Bill Stribling Ranch north of Johnson City for wildlife cover. Goats and deer find the sprouts good browse. However, the trees are sources of seed, and follow-up is needed to control spread.

The most important step in restoration and maintenance of grasslands is judicious use of the plants. Plants manufacture food in their leaves from carbon dioxide taken from the air, and nutrients absorbed from the soil. Remove the leaves and the plant can't grow, showing how important the leaves are in the growth processes of the plant. Continuous close grazing will prevent the leaves from making foods, and will result in eventual death of the plant.

It has been found that plants can make satisfactory growth if no more than about half of the leaves are removed. This fact is the key in successful ranching. A good stand of vigorous grasses is nature's best defense against invading weeds, shrubs, and trees, as well as insurance and reserve feed for a drought.

Dusan Pakan of Wheeler controlled sagebrush, sumac, and shin oak by spraying, and then rested the pasture two growing seasons. The thick stand of grasses furnishes excellent forage for livestock. Prairie chickens are increasing on this range.



Management of livestock to avoid excessive use is essential. Rainfall fluctuates widely and so does the forage produced. This requires seasonal and yearly changes in herd numbers, for it is during the dry years that the grasses can be hurt the most. Flexibility in animal numbers is needed to make adjustments in line with forage produced. For this reason, it is best to carry a permanent or base herd somewhat below the number that the forage will support in a good year. The extra forage produced in good years can be harvested with carryover or stocker animals. It is also important that the herd can be reduced readily without undue sacrifice when shortages occur.

It is wise management and good business to carry a feed reserve for poor moisture years. As shown in the photo below, reserve forage may be in



the form of extra grass on the ground, reserve or rested pastures, stored feeds, or grazing crops. It will never hurt the rancher to have some extra feed, but it will hurt to have to buy high-priced feeds or to lose animals or production because the forage ran out.

Range restoration is not a simple job. It requires technical knowledge of many subjects. It requires an evaluation of the many-sided problems involved, and an analysis of the possible solutions to achieve the optimum benefits desired. It requires the development of a plan and systematic application of the needed treatment that will give the maximum results in line with the rancher's wishes and financial resources.

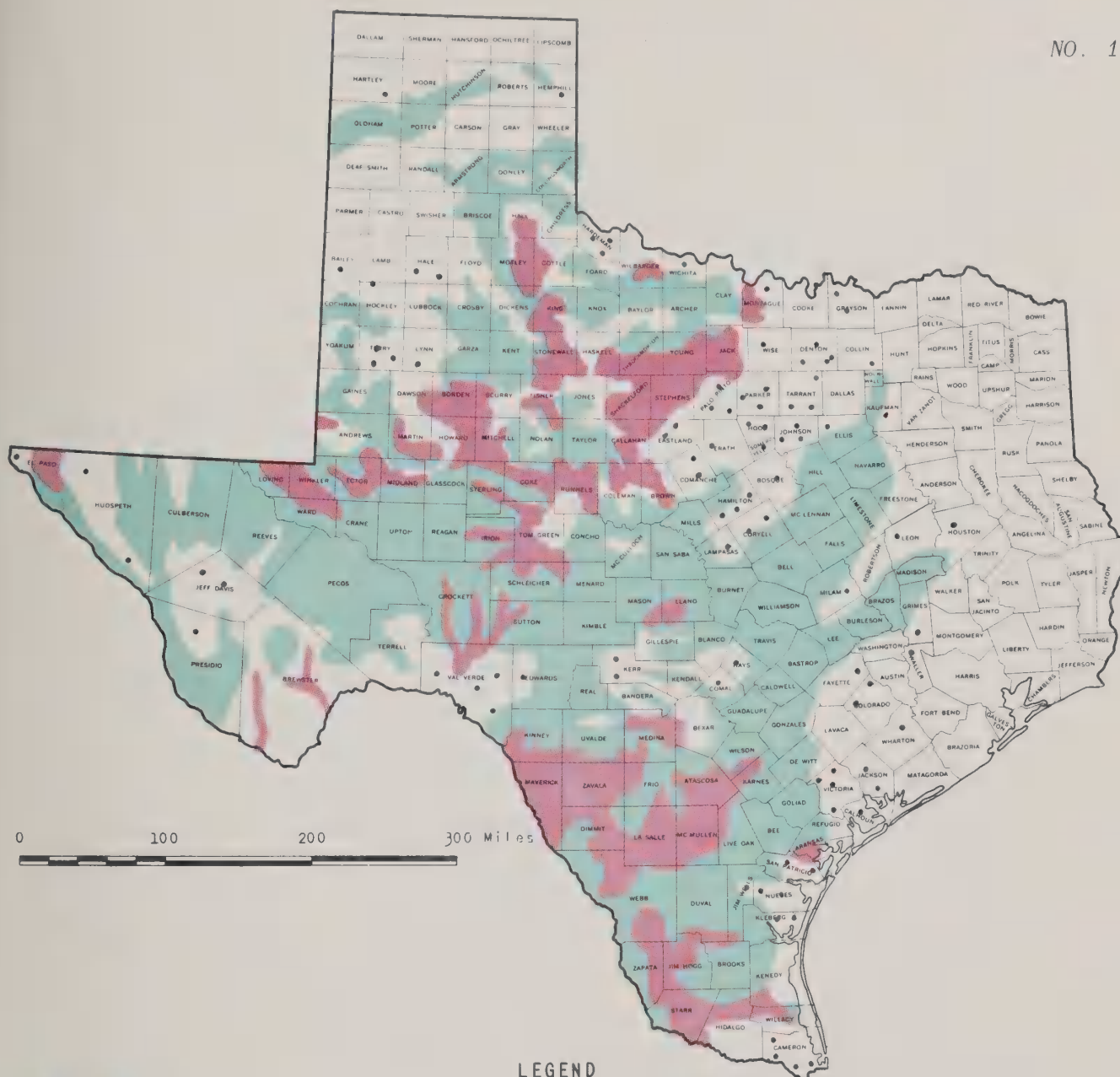


The high cost and complexity of the problems, the many species involved, the treatment required, and the need for more effective control measures for some species of brush make it imperative that long-range plans be developed and carried out by all concerned. An all-out approach will involve research, financing, educational, and operational agencies, as well as unified and widespread action by the livestock operators themselves through their soil conservation districts, associations, and other organizations.

APPENDIX.....

Maps showing the distribution and density of major species of Brush in Texas:

1. Mesquite
2. Junipers (Cedars)
3. Post and Blackjack Oaks
4. Live Oak
5. Shin Oaks
6. Cactus
7. Huisache and Retama
8. Blackbrush Acacia
9. Guajillo
10. Whitebrush
11. Saltcedar (Tamarisk)
12. Yaupon
13. Sand Sagebrush
14. Macartney Rose
15. Winged Elm
16. Creosotebush and Tarbush



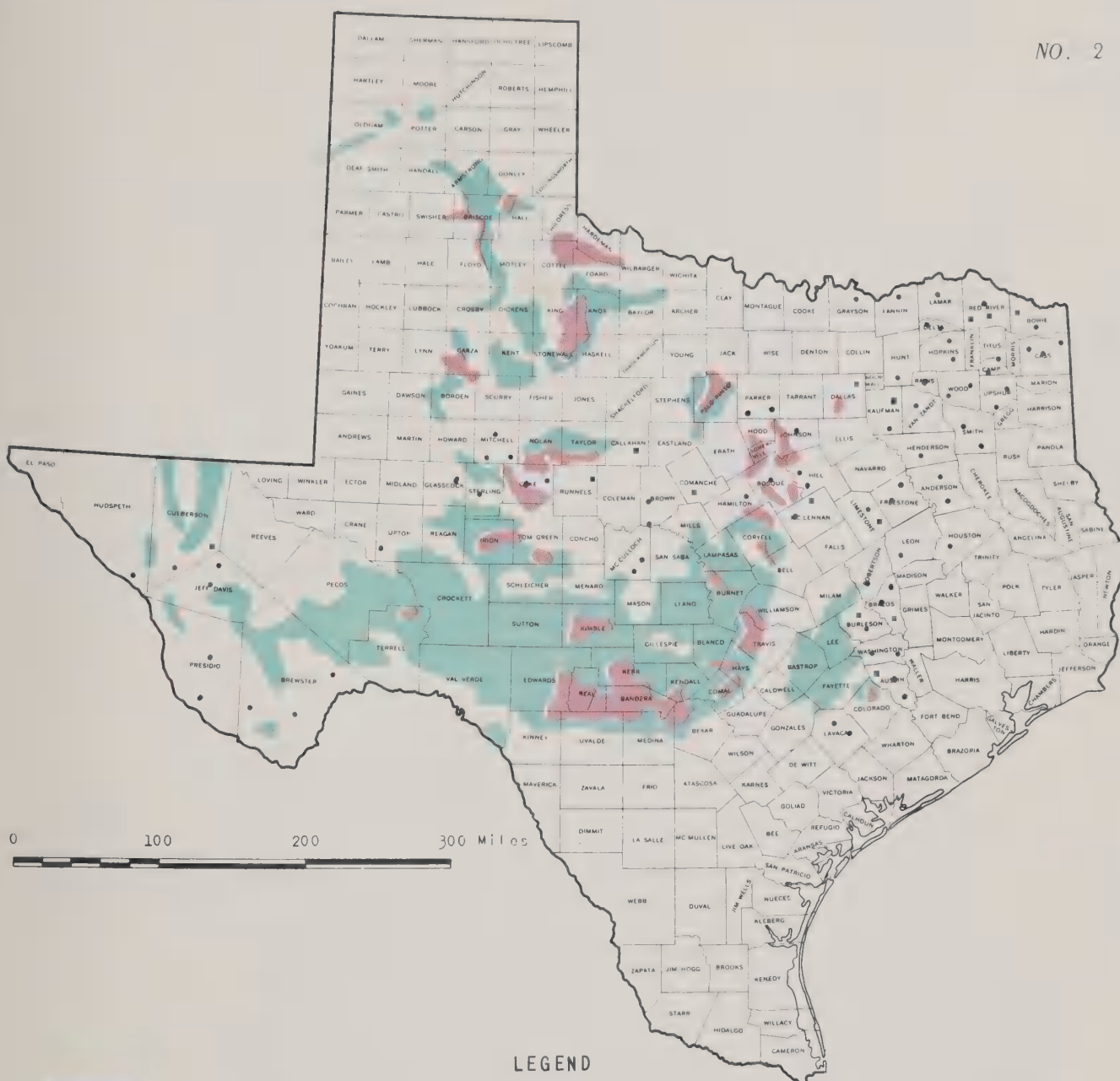
BRUSH SURVEY - TEXAS

MESQUITE - *Prosopis juliflora*

Brush Survey by Soil Conservation Service, 1963-64

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Temple, Texas

6-64 4-L-19113-1



LEGEND



Dense Stands (More than 20% canopy)

3,392,500 Acres

Light to Moderate Stands (Less than 20% canopy)

18,119,000 Acres



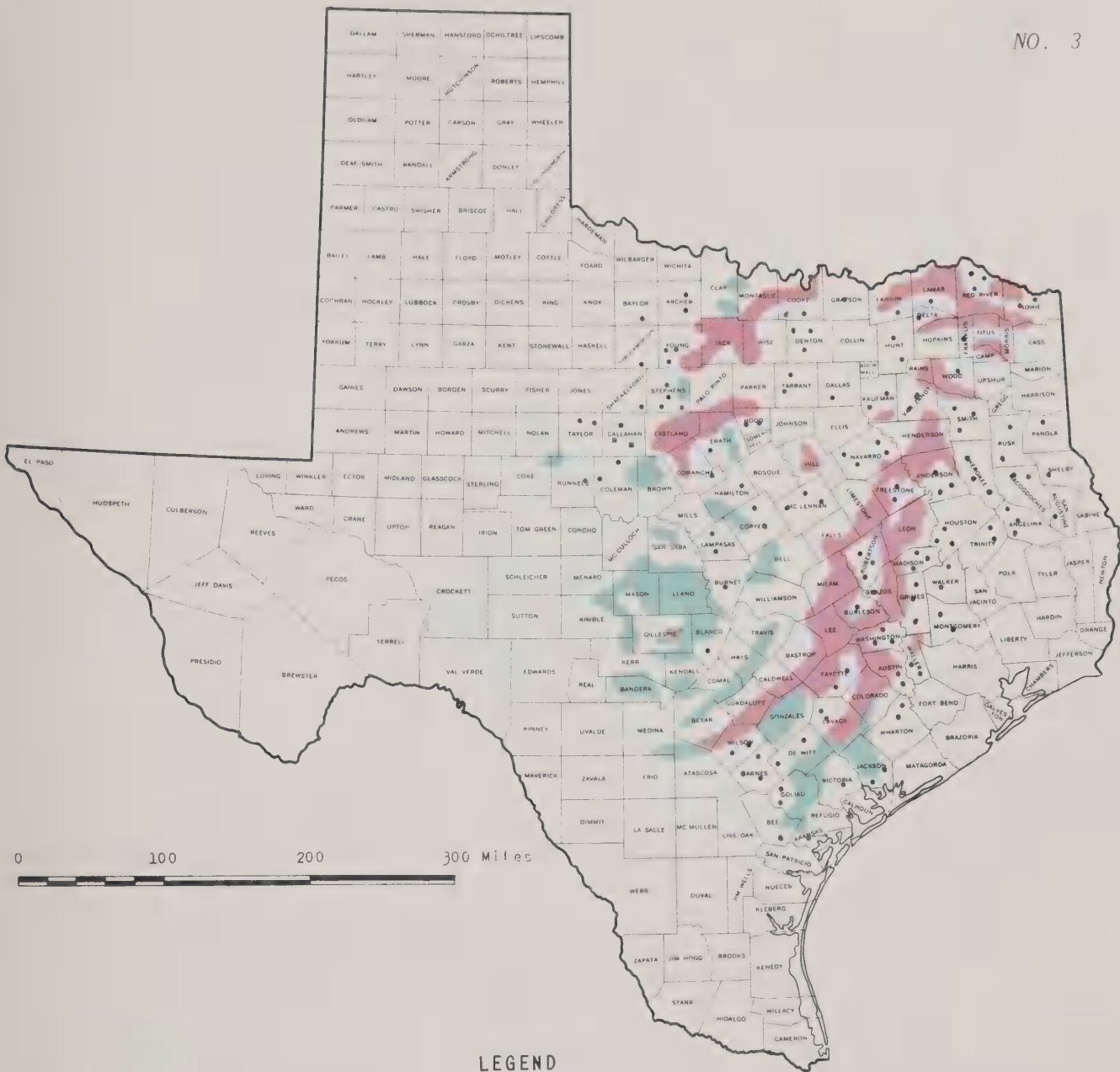
Scattered Trees or Small Groves


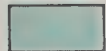

Total Acres Infested

21,511,500 Acres

BRUSH SURVEY - TEXAS

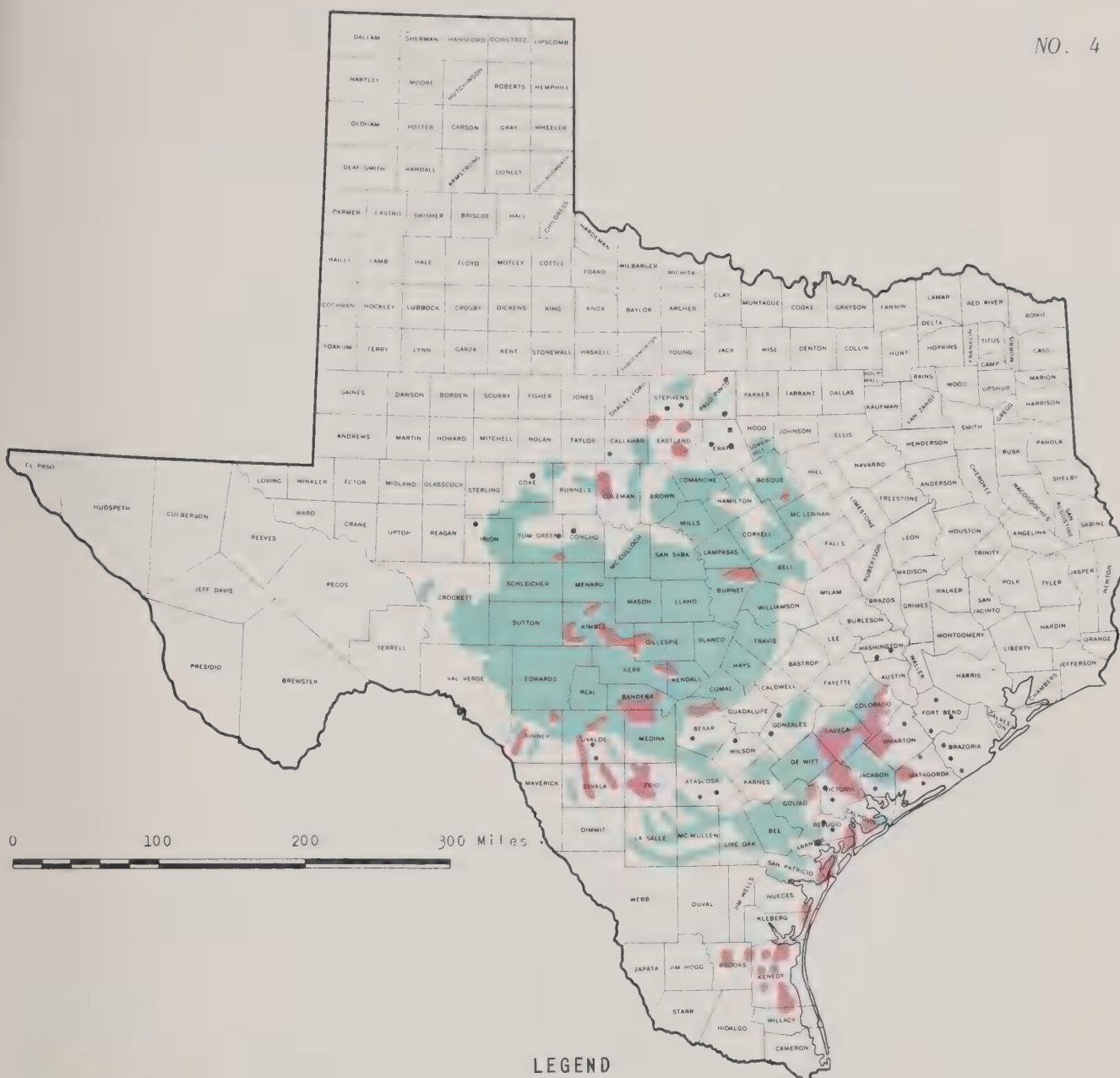
JUNIPERS (CEDARS) - *Juniperus pinchoti*, *ashei* and *virginiana*



LEGEND		
	Dense Stands (More than 20% canopy)	5,803,200 Acres
	Light to Medium Stands (Less than 20% canopy)	5,498,600 Acres
	Scattered Trees or Small Groves	
Total Acres		11,301,600 Acres

BRUSH SURVEY - TEXAS

POST AND BLACKJACK OAKS - (*Quercus stellata* and *marylandica*)

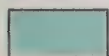


LEGEND



Dense Stands (More than 20% canopy)

1,821,200 Acres



Light to Moderate Stands (Less than 20% canopy)

14,219,500 Acres



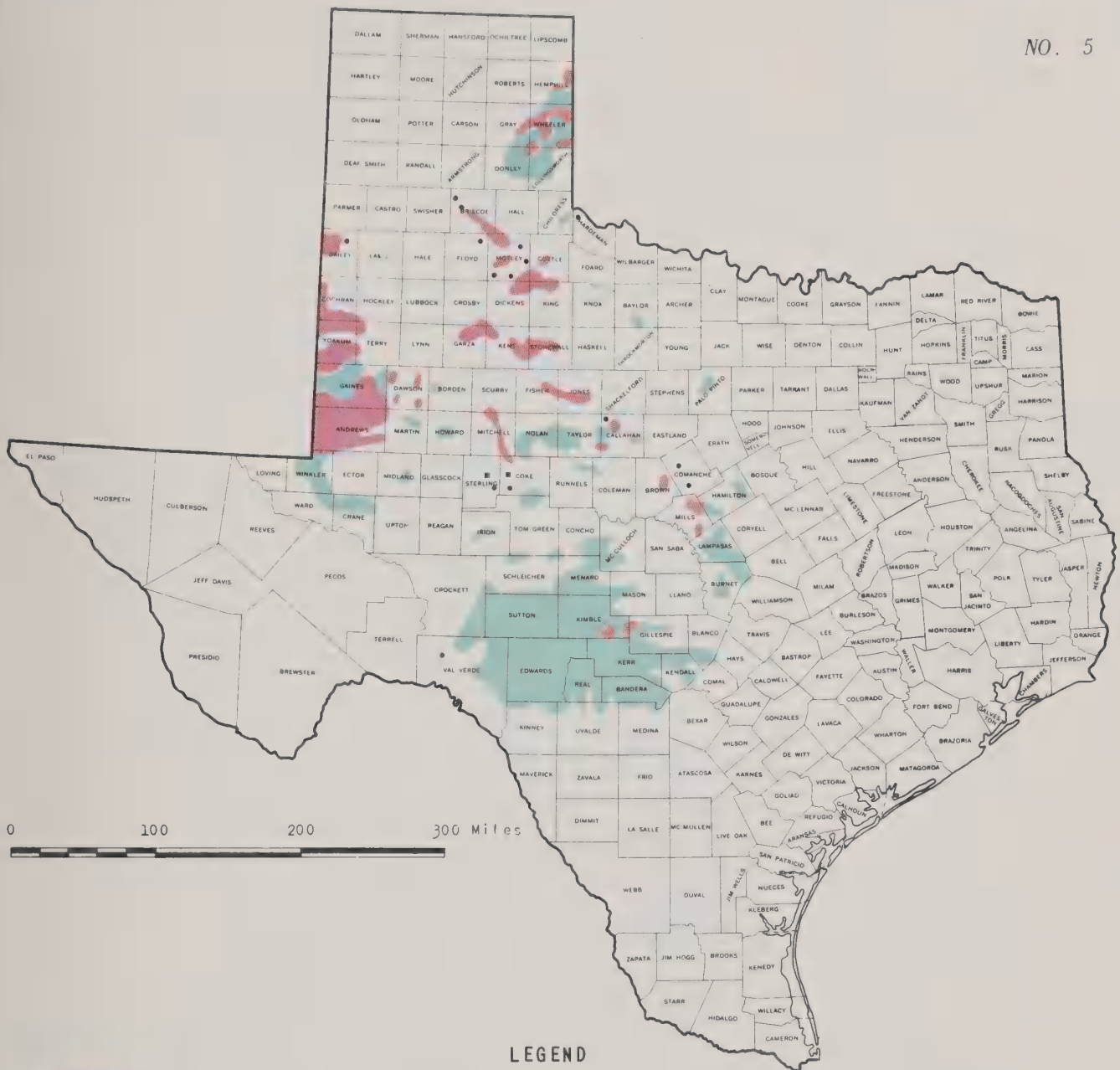
Scattered Trees or Groves

Total Acres

16,040,700 Acres

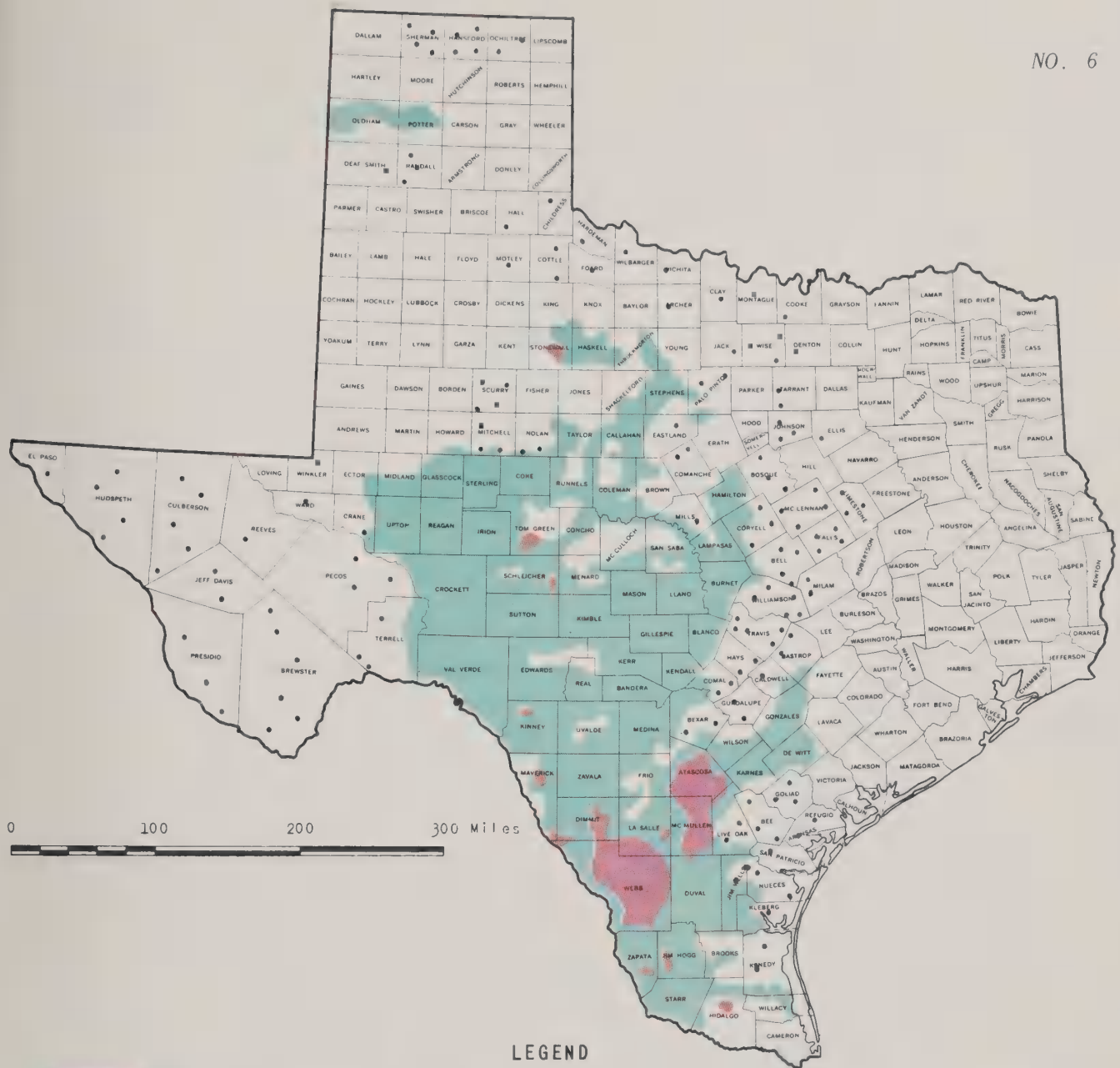
BRUSH SURVEY - TEXAS

LIVE OAK - *Quercus virginiana*



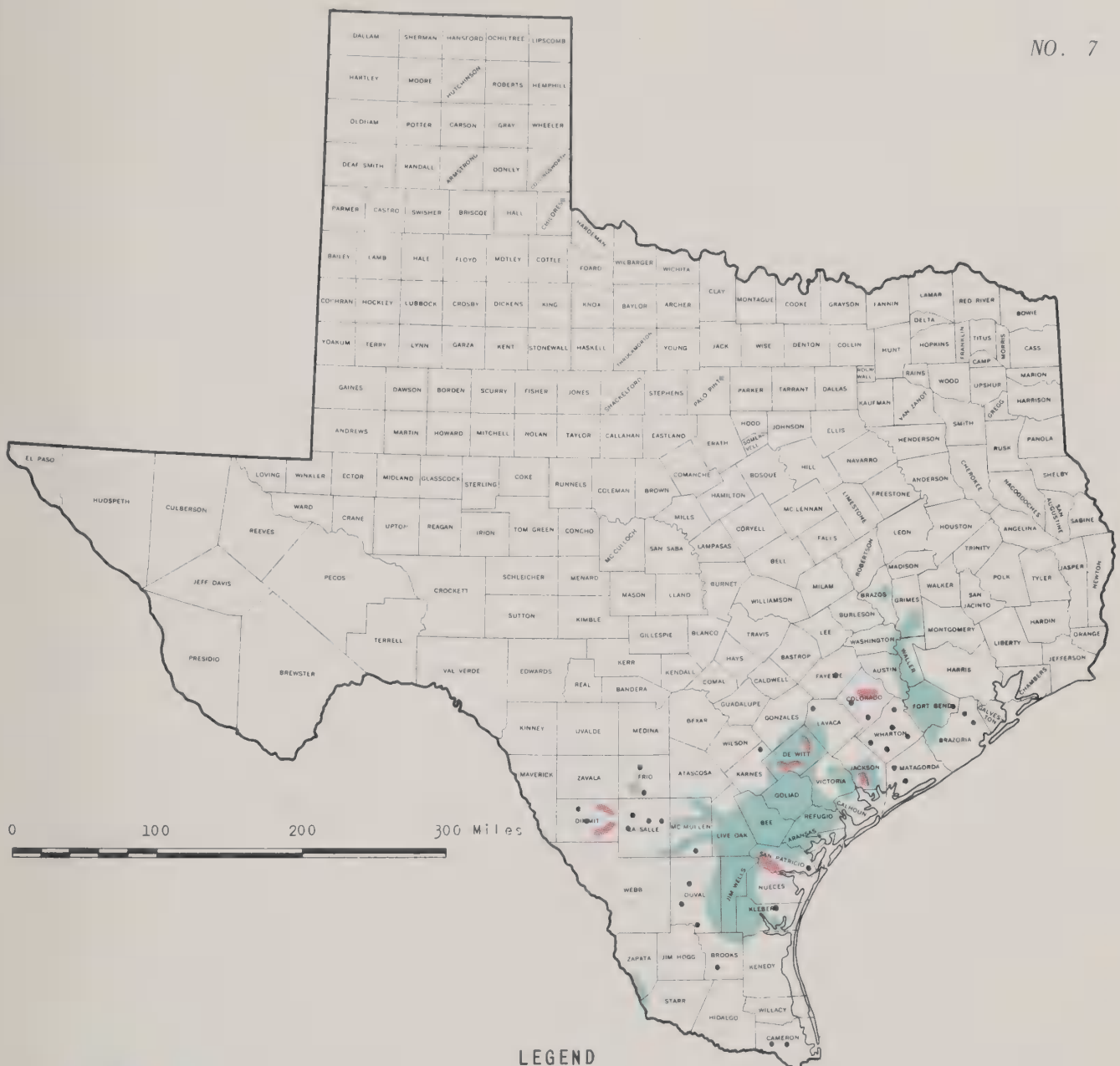
BRUSH SURVEY - TEXAS

SHIN OAKS - *Quercus* species



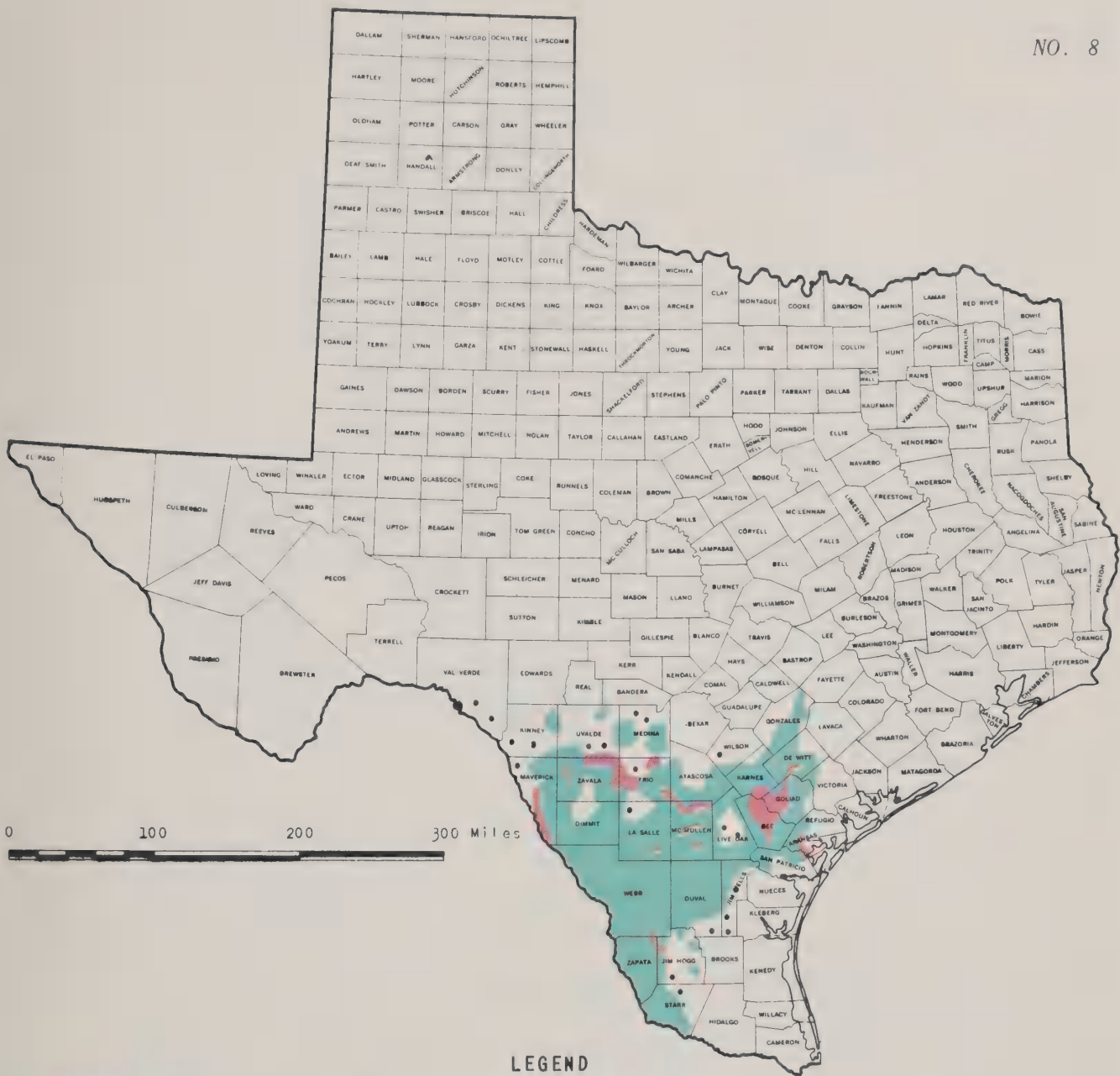
BRUSH SURVEY - TEXAS

CACTUS - Pricklypear, tasajillo and cholla



BRUSH SURVEY - TEXAS

HUISACHE AND RETAMA - *Acacia farnesiana* and *Parkinsonia aculeata*



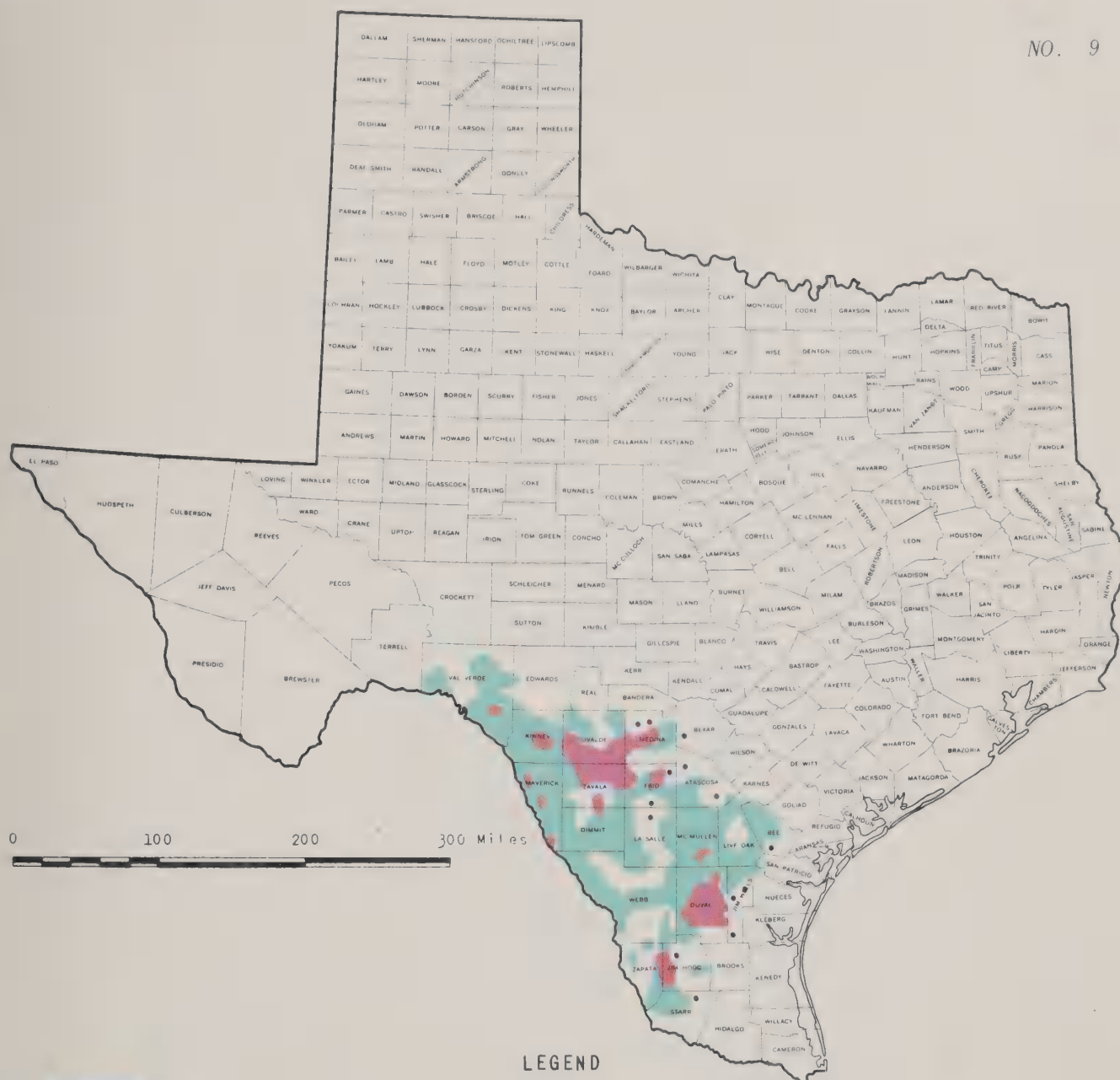
BRUSH SURVEY - TEXAS

BLACKBRUSH ACACIA - *Acacia rigidula* (A. amentacea)

Brush Survey by Soil Conservation Service, 1963-64

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Temple, Texas

6-64 4-L-19113-8



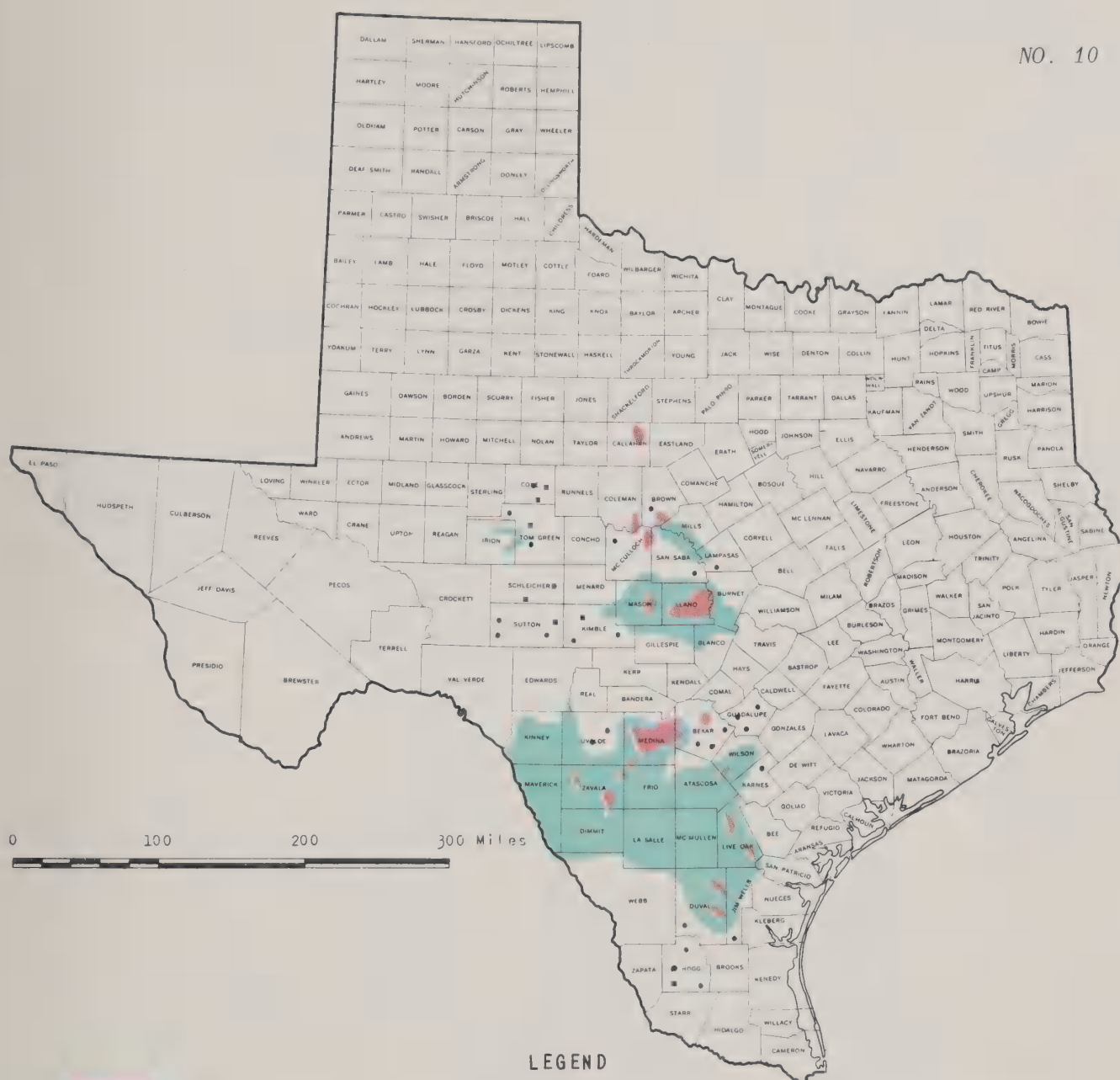
BRUSH SURVEY - TEXAS

GUAJILLO - *Acacia berlandieri*

Brush Survey by Soil Conservation Service, 1963-64

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Temple, Texas

6-64 4-L-19113-9



LEGEND



Dense Stands (More than 20% canopy)

853,900 Acres

Light to Moderate Stands (Less than 20% canopy)

5,191,400 Acres



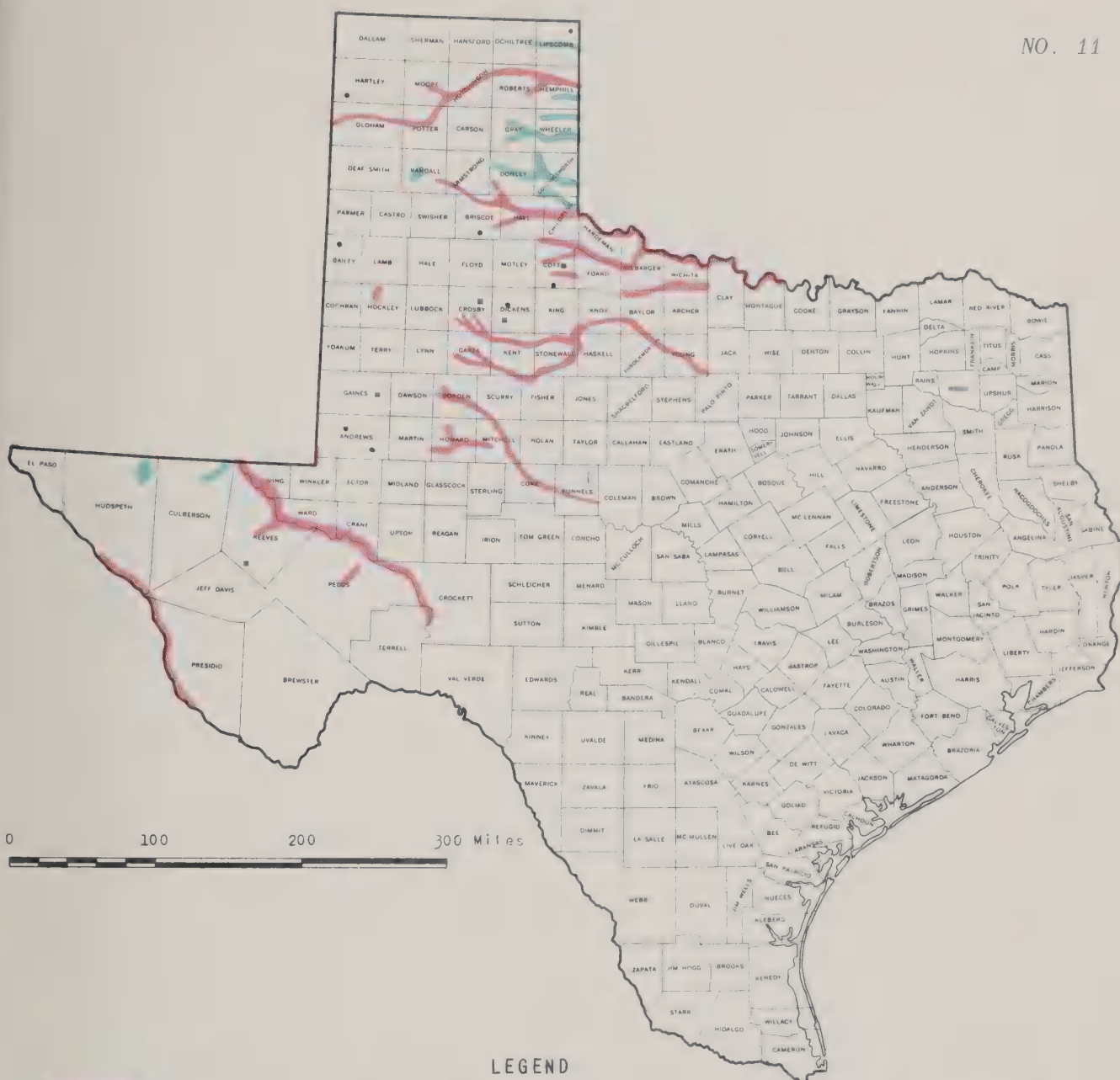
Scattered Plants or Small Areas Infested

Total Acres Infested

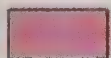
6,045,300 Acres

BRUSH SURVEY - TEXAS

WHITEBRUSH - *Aloysia lycioides* (A. ligustrina)

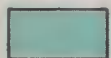


LEGEND



Dense Stands (More than 20% canopy)

273,000 Acres



Light to Moderate Stands (Less than 20% canopy)

250,900 Acres



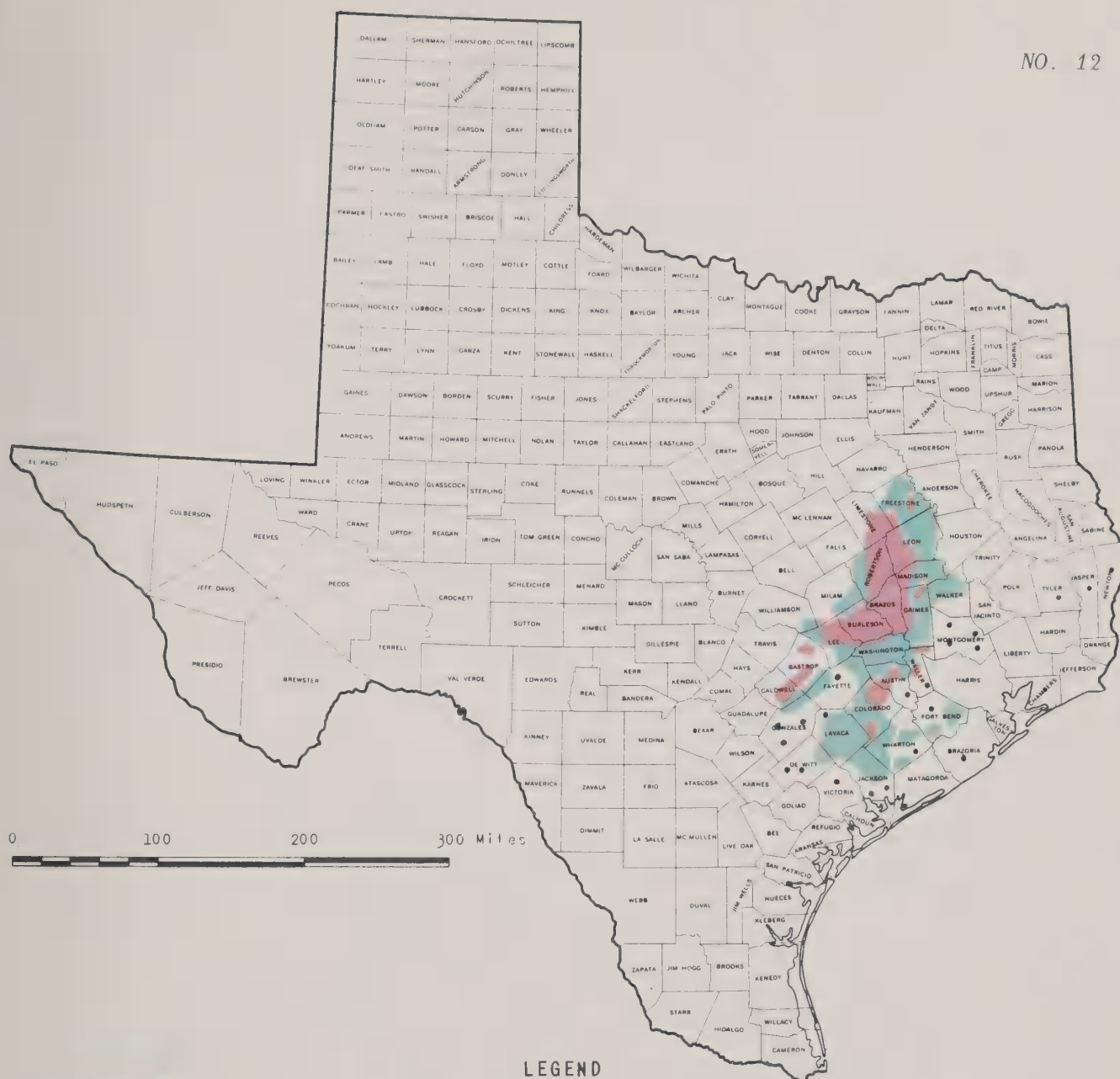
Scattered Trees or Small Infested Areas

Total Acres Infested

523,900 Acres

BRUSH SURVEY - TEXAS

SALT CEDAR (TAMARISK) - *Tamarix gallica*



LEGEND



Dense Stands (More than 20% canopy)

1,043,200 Acres

Light to Medium Stands (Less than 20% canopy)

1,581,200 Acres

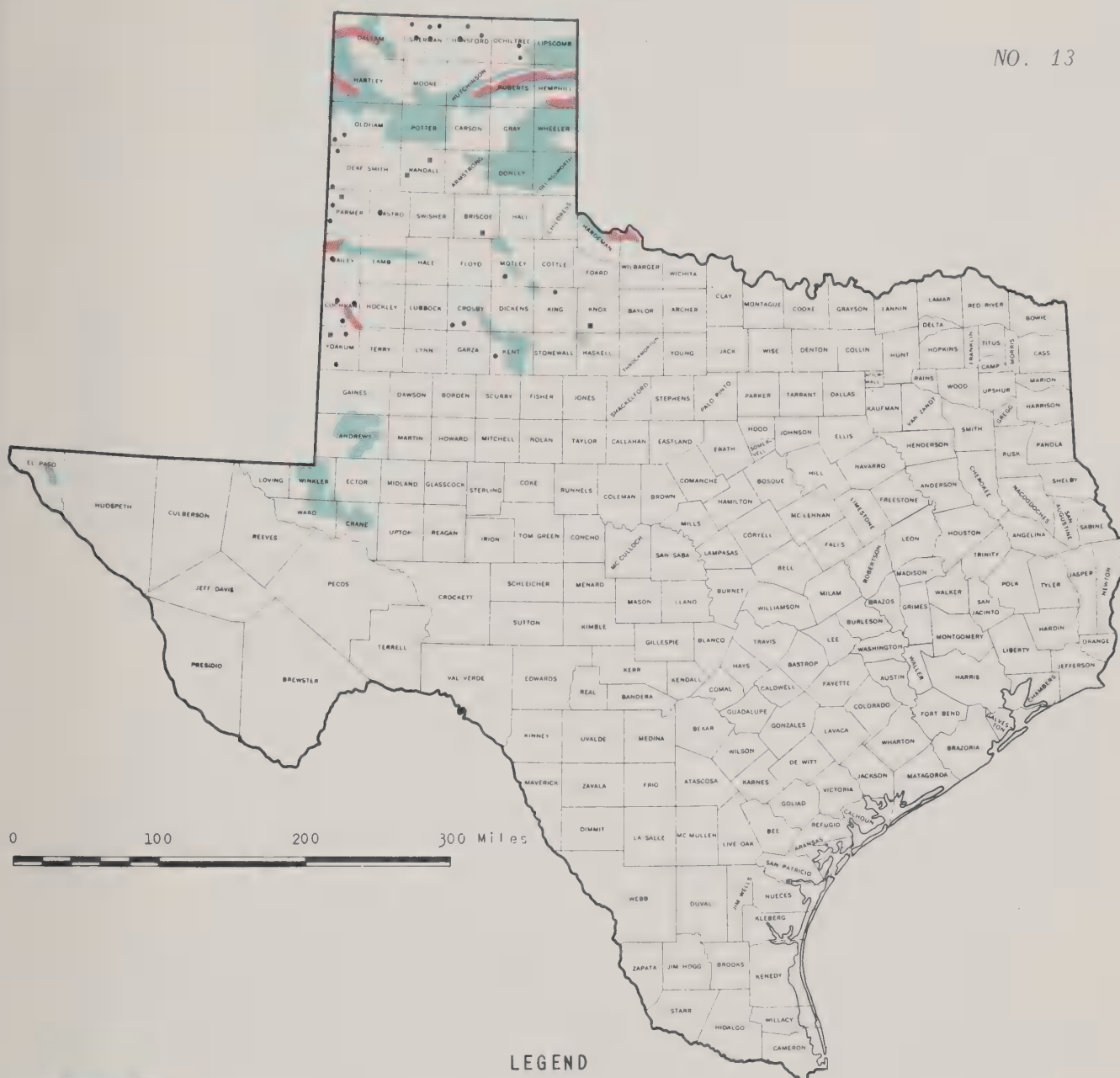


Scattered Plants or Small Areas of Infestation

Total Acres Infested 2,624,400 Acres

BRUSH SURVEY - TEXAS

YAUPON - *Ilex vomitoria*



Dense Stands (More than 20% canopy)

701,800 Acres

Light to Moderate Stands (Less than 20% canopy)

4,403,200 Acres

Scattered Plants or Small Infested Areas

Total Acres Infested

5,105,000 Acres

BRUSH SURVEY - TEXAS

SAND SAGEBRUSH - *Artemisia filifolia*

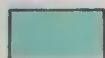


LEGEND



Dense Stands (More than 20% canopy)

44,900 Acres



Light to Moderate Stands (Less than 20% canopy)

230,700 Acres



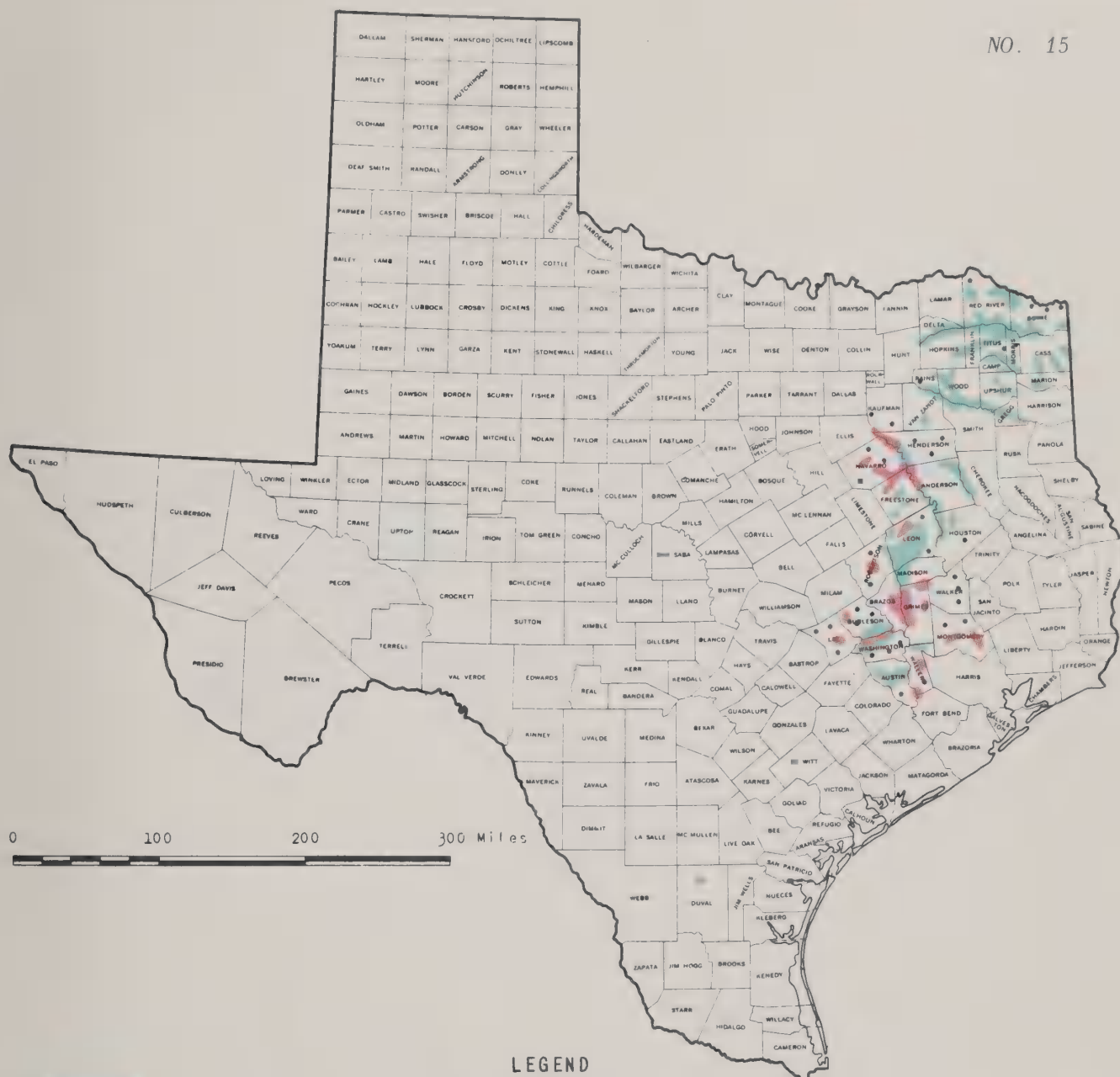
Scattered Plants or Small Infested Areas

Total Acres Infested

275,600 Acres

BRUSH SURVEY - TEXAS

MACARTNEY ROSE - *Rosa bracteata*



Dense Stands (More than 20% canopy)

646,500 Acres

Light to Moderate Stands (Less than 20% canopy)

1,905,700 Acres



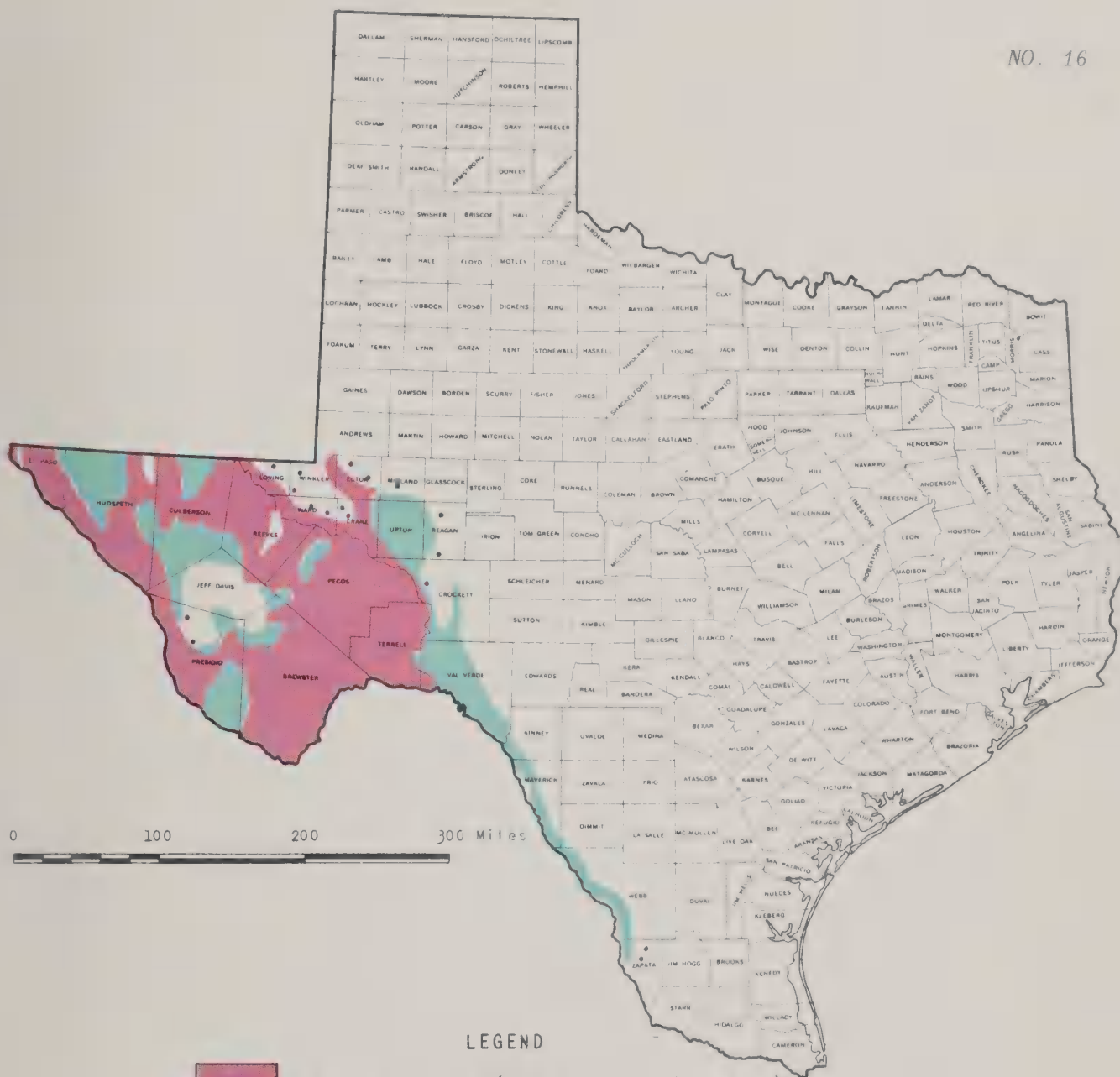
Scattered Trees or Small Groves

Total Acres Infested

2,552,200 Acres

BRUSH SURVEY - TEXAS

WINGED ELM - *Ulmus alata*



LEGEND



Dense Stands (More than 20% canopy)



Light to Moderate Stands (Less than 20% canopy)



Scattered Plants or Small Patches

Total Acres Infested - Creosotebush 16,300,000 Acres

Tarbush 12,100,000 Acres

BRUSH SURVEY - TEXAS

CREOSOTEBUSH AND TARBUSH - *Larrea divaricata* (L. tridentata)
and *Flourensia cernua*

aSB199

.U5

v.2

GRASSLAND RESTORATION

PART II . . . BRUSH CONTROL



UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE
Temple, Texas - December 1964

The basis for successful ranch operation is production and maintenance of an adequate supply of high quality forage for livestock. This forage will be in the form of grass, browse and sometimes, supplemental feed crops. The rancher keeps livestock for the purpose of converting such plants into a marketable product. Too severe harvesting of these plants decreases their productivity or destroys them.

The grasslands of Texas were once among the most luxuriant in the nation, and the base for a great livestock industry. Heavy use and drought have brought about change in the natural grass cover, resulting in serious infestation of hardier but undesirable woody plants. Data regarding extent and severity of the brush infestation in Texas are presented in the report: GRASSLAND RESTORATION - THE TEXAS BRUSH PROBLEM - by H. N. Smith and C. A. Rechenthin, USDA, Soil Conservation Service, Temple, Texas, June 1964. Eighty-two percent, or 88.5 million acres, of Texas grasslands are now infested with some kind of woody plant. Fifty percent are so densely infested that satisfactory forage production cannot be obtained without some form of brush control to lessen competition and enable the good grasses to come back.

Livestock operators are confronted with an ever-tightening cost-price squeeze between rising cost of production and what they receive for their products. The obvious first opportunity the rancher has to meet this trend is to reduce cost of production by producing more and better forage on his grasslands. However, brush robs the rancher of his soil, water, and plant resources. Control of brush, therefore, is the first necessary step in the restoration of grassland productivity on millions of acres.

Another increasingly evident interest that both ranchers and the entire public have is that brush materially reduces the water yield of infested watersheds. This affects agricultural water supply and that of small municipalities and industries and ultimately the supply of larger communities and industries downstream.

Presented in the following pages are the currently best-known methods of control, where they are applicable, and costs and benefits that can be expected. The complexity of the problem and control methods make it imperative that control be carried out as a part of a complete plan of grassland restoration and use. Brush control is a highly technical operation because of widely varying conditions. It should be done with the on-site aid of a technically qualified man as is available to ranchers through their soil conservation districts. Much additional research is needed on this problem. Some financial assistance is available through the Agricultural Conservation Program, and in the northwest and west parts of the state through the Great Plains Conservation Program, and as loans through the Farmers Home Administration.

Brush control will be a never-ending effort requiring the fullest participation of ranchers, businessmen, water users, and agencies of State and Federal Governments.

The assistance of Dr. C. L. Leinweber and other members of the Range and Forestry Department, and Garlyn Hoffman, Extension Range Specialist, of Texas A&M University in reviewing and making suggestions for improvement, and for the use of the top photo on the cover page, is gratefully acknowledged.

H. N. Smith

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APR 20 1977

H. N. Smith
State Conservationist
Soil Conservation Service
Texas

CATALOGING DEPT



Once infested with dense cedar and other brush, this pasture has been restored to grassland.

GRASSLAND RESTORATION

PART II - BRUSH CONTROL

By C. A. Rechenthin, H. M. Bell, R. J. Pederson,
and D. B. Polk-Range Conservationists

Grassland improvement is the greatest opportunity that many livestock operators have to reduce cost of production in meeting the cost-price squeeze.

Grassland improvement must be carried out as a part of a coordinated, long-range plan which includes all the treatment needed to bring the grasslands back and maintain their potential among the foremost grazing resources of the nation. Controlling undesirable woody plants that rob the operators of their soil and water resources is an essential first step in the restoration of millions of acres of Texas grasslands.

Treatment for control of brush is complex and difficult for many reasons. The many species involved, often in mixtures, complicates control as each species may require different treatment. Control of one kind may release another which may become as great a problem as the original infestation. Methods known and used today are often only partially

effective or they vary in their effectiveness, for reasons not well understood. Diverse conditions of soil, moisture, and climate that occur over the state may cause a treatment to be less effective in some parts than in others. Reinfestation from seeds and root sprouts frequently requires additional control measures in from five to ten years or less, unless the treatment is followed by good management.

Another item of concern in controlling brush is that many species are good browse plants for livestock, and some are good browse, food, and cover plants for wildlife. It is important that sufficient of these plants be retained to furnish part of livestock feed and to provide suitable wildlife habitat and feed. It usually is desirable to apply selective control, leaving kinds that are beneficial in the proper amounts.

The use of chemicals in controlling brush becomes a problem near cropland areas. The danger of drift from herbicides may imperil cotton or other field crops nearby unless timing, equipment, and material which minimize this danger are used.

The cost of control treatment in itself is a major factor to consider. At best it is an expensive operation that varies widely in cost and effectiveness. Generally, the cost ranges from a low of about \$3.00 per acre upward. Repeat or follow-up treatment to control sprouts and seedlings is often necessary. Complete treatment to restore the productivity of some severely infested grasslands, which may include brush control, raking, stacking, burning, seeding, fencing, and other measures, may require an outlay of as much as \$35 per acre. Such cost prevents some operators with limited financial resources from doing an adequate or complete job, and this influences effectiveness of treatment of neighboring areas. Untreated areas are an important source of seed to reinfest treated areas.

Ranchers, equipment companies, and contractors have developed many of the improved mechanical methods being used today. Experiment stations and chemical companies have developed the chemical control methods, and are continuing to study and develop new methods.

It is estimated that 30 to 35 million acres of brush in Texas have already been treated, but thousands of acres have become reinfested by regrowth or new seedlings. About 15 million acres were considered as still being effectively controlled in July 1963; some of that had been treated two or three times. Reinfestation is a constant problem on all treated areas. Brush control at this time appears to be a never ending management problem.

Because of the great number of species involved, the variety of conditions existing over the state, reinfestation, problems of erratic and ineffective control, and the need for restoring and managing the grass, the planning of successful brush control makes the job a highly technical one, for which the ranchers should get qualified on-site technical assistance and guidance before applying expensive control measures.

..... MECHANICAL METHODS OF CONTROL

Hand Methods

Hand methods are oldest and often the most effective. They are slow and costly and, therefore, limited in usage. Hand methods are: grubbing, cutting, girdling, and burning. Some of these methods are used in combination with chemical treatment, which is discussed under the section on chemicals.

TE - 43 - 563



Grubbing

TE - 1679 - 4



Grubbing consists of digging out the plant with as much of the root system as necessary to kill the plant. It is an expensive operation which is used mostly on scattered trees or in cleaning up pricklypear and other cactus. It is particularly effective on pricklypear because with care all the pads are stacked and sprayed, whereas mechanical equipment tends to scatter the pads. It is necessary to dig deep enough to get the bud zone on mesquites, usually 14 to 16 inches beneath the surface for control by grubbing.

Cutting or Axing

Cutting with an ax is a widely used and effective method of controlling blueberry juniper and eastern redcedar which are killed when the green leaves and branches are removed.

TE-188-4



The range above was cleared of cedar, the stumps visible amid the excellent stand of grass. The pasture was rested following treatment, and it has been conservatively grazed since. Oak and other good browse and wildlife plants remain for cover and food. Although labor cost is high, the posts cut out of an old stand of blueberry juniper sometimes pay for the cutting operation.

Cutting with an ax or saw is sometimes used on other kinds of trees when in small areas or scattered stands. Cutting must generally be followed with chemical stump treatment on root-sprouting plants such as oak and mesquite. Cutting may be done any time in the year but is most effective in spring or early summer when the sap has risen.

Girdling

Girdling consists of cutting the cambium layer in a ring around the tree trunk with an ax or saw, thereby stopping movement of sap and nutrients to the top. It is an old method used mostly on scattered trees or small groves.

E. R. Saathoff of the Medina Valley Soil Conservation District girdled oaks, elms, and other heavy timber in a valley site and seeded the area to grasses. This operation plus good management has brought back good pasture two years later.

The optimum time for girdling is from May 1 to September 1. It is most effective on trees more than eight inches in diameter in eastern Texas, or on trees six inches or larger west of the 35-inch rainfall belt. Girdling

is often done in combination with chemical treatment to assist in getting the chemical into the trunk.



Burning

Burning is an extremely dangerous and hazardous treatment and must be used with utmost precaution. It has limited application in the eastern part of the state, still somewhat on a trial basis. Adequate protection must be made against wild fires, such as construction of fire lanes, and fire control equipment.

Burning is effective to control underbrush including yaupon, elm, hawthorn, and skunkbush, but does not kill root-sprouting plants such as beautyberry. It can be used as a follow-up control method where other methods have killed the larger trees. Burning should be done in the spring when the sap is rising, the soil surface is moist, and when rains can be expected to bring out the grass. Dry spells after a fire can be very destructive to the grass cover. All of the pasture should be burned because livestock and deer tend to concentrate on burned areas, causing excessive grazing damage if only a part of a pasture is burned. Seeding adapted grasses in freshly burned areas has been used to speed up recovery. Burning has the advantage of low cost, as little as 25¢ per acre; but the danger of wildfires and damage to grasses and other good forage plants is always present and is a big disadvantage.

Power Methods of Control

There is a great variety of power equipment being used for brush control, ranging from small power saws and girdlers to immense machines that uproot trees at the rate of several acres per hour. Power equipment reduces labor requirements and some types of treatment are very

effective. The high cost of equipment makes many mechanical methods necessarily expensive.

The power methods of mechanical control can be grouped as: portable power saws and girdlers, dozing, chaining, railing, chopping, disking, mowing or shredding, and rootplowing.

Power Saws and Girdlers

Portable power saws and girdlers have the same general application as hand cutting and girdling. They reduce the cost of labor required, and therefore can be used on a larger scale, but are still limited to small areas or to scattered trees.

Dozing

TEX-44-100



TEX 44-082



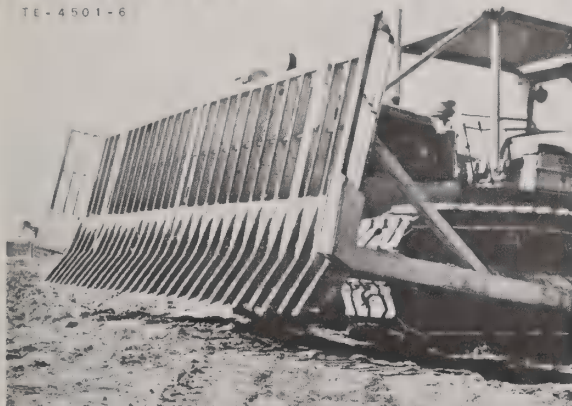
Dozing is one of the more effective methods of controlling larger trees and brush because it pushes or pulls the plants out by the roots. There are numerous types of dozing equipment, including the straight dozer blade and various modifications using attachments such as teeth, as pictured on the right, and a U-shaped "stinger" attachment, shown on the left, with which it is possible to cut below the roots and lift the plant out of the ground.

Dozing is most applicable to open stands of larger trees and brush or to rocky soils where other mechanical methods are limited. It is not desirable for thick stands of mesquite and chaparral, many species of which rootsprout. Dozing is most effective in summer but can be done any time of the year. However, if seeding is to follow, it is desirable to doze prior to the spring planting season so that the seed can be broadcast into the freshly disturbed area before weeds become a problem.

Dozed brush is often windrowed or stacked, where it is burned or left to decay. Brush piles serve as cover for wildlife and protection for grass seedlings until they become established. If tame pastures are to be seeded, necessitating mowing and fertilizing and the use of other equipment, it is usually desirable to burn the brush to clear the area.



TE-4501-6



TE-2861-6

Brush windrowed on sloping lands can help to control erosion and runoff. The windrows on this (top photo) steeply sloping land will help to get grass back on the slopes.

A modification of dozing (center photo), using a toothed, rake-like "stacker" with teeth 5-1/2 to 14 inches apart instead of the solid blade, is being used on pricklypear and smaller brush with considerable success. The teeth pull the plants out by the roots and also break up the soil surface, preparing a good seedbed, since seeding is nearly always needed. This is an advantage over the dozer blade which tends to make a smooth cut, less favorable for seeding. The pricklypear and brush are stacked to get them out of the way where they can be burned or left to decay.

The stacker has been found very useful on thick stands of pricklypear (lower photo) that have developed on rootplowed areas.

The cost of dozing operations may present an economic problem. Dozing thick stands of mesquite and small oaks may cost as much as \$12 to \$20 per acre or more for larger trees. Thin stands may be dozed at a lesser cost. Pricklypear can be dozed and stacked for about \$5.50 to \$6.00 per acre with the stacker shown,

but generally at a higher cost with smaller equipment. Follow-up is required because small plants are missed and rootsprouts and seedlings soon appear.

Chaining

Chaining is a relatively cheap method of control but has only temporary and limited effectiveness. Naval anchor chains at least 100 feet long

and with links of 80 pounds or more are pulled behind two tractors. A chain-like drag made of crawler-type tractor tracks has also been used and is more effective because of the heavier weight. Cables, usually one inch in diameter, were formerly used extensively but are not so effective as chains. Two-way chaining, first in one direction and again in the opposite, is more effective than one way and well worth the extra expense because more of the brush is pulled out.

TE-2608-8



The main advantage of chaining is low cost; two-way chaining costs from \$2.50 to \$3.50 on small brush or \$4 to \$5 on larger brush and trees. There is an immediate release of moisture competition and opening up of the area so that livestock can be worked more easily.

Chaining obtains the greatest kill of plants when used on single-stemmed trees such as oaks, blueberry juniper, and tree-type mesquites, growing on loose, sandy or shallow soils, or moist soils where the roots can be pulled out. Otherwise, the tops bend over or break off, permitting prolific resprouting, the main problem when chaining brushy types of woody plants. Chains also tend to "ride over" very dense stands of oaks and similar trees that ball up under the chain, pulling the trees over but not uprooting them. Chaining seldom is effective control of red-berry juniper because the smaller plants only bend over.

Chaining is sometimes used as a preliminary treatment to knock down a thick growth of large trees on areas later to be rootplowed. Chaining makes it easier to rootplow and often justifies the cost in dense stands of large brush. Chaining is also an effective method of knocking down brush where it is planned to control sprouts with goats.

Pricklypear and tasajillo are often spread by chaining, making this method of control inadvisable where cactus is present. Although chaining does tear up some of the ground as it pulls up the brush, it has a tendency to crush and pulverize the soil, making a less desirable seedbed. Brush that is dropped by the chain is in the way of seed drills so it is advisable to use another method of control if seeding is needed to restore the grasses.

Railing

TE-3870-11



Railing has been developed for the control of pricklypear and tasajillo in South Texas. The rail drag consists of three to nine railroad rails or heavy angle irons welded or chained together in tandem in sets of two or three. The rails are dragged twice over the area in opposite directions; this crushes most of the cactus stems and pads. To clean up the crushed, broken pads and prevent their taking root, cattle are sometimes turned into the newly treated area. Railing is most effective in summer when the dry hot weather will assist in killing the broken pads before they root. The rail treatment is usually repeated by one dragging about a month afterward or the following spring to catch any new sprouts and pads missed the first time.

Railing is not adapted to areas having large trees or brush but can be used on small brush, the size determined by the size of the tractor and weight of the rails.

Pricklypear can be railed three times over at a cost of about \$5 to \$6 per acre; or it can be railed two times for about \$3 to \$4 per acre. The operation tends to pull up grass that may be growing on the treated area, so the method is most desirable for areas having little grass and on which seeding is planned. The surface of the soil is fairly well torn

up, and the cactus and brush are crushed so that the railed area can generally be covered with a grass seed drill or chopper. Good results have been obtained from seeding railed areas.

Chopping

TEX 47-802



The chopping operation is done with a roller equipped with cutting blades. Choppers range from small cottonstalk cutters to implements of 15,000 to 20,000 pounds or larger, as pictured above. The blades are spaced so they are about 8 to 14 inches apart. A weight of about 1,500 to 2,000 pounds per linear foot of cutter blade is suitable for medium sized brush like the condalias, granjeno, catclaw, blackbrush acacia, and guajillo. The larger choppers are needed for average mesquite and similar sized trees.



A large self-propelled chopper which rolls on three cutter-equipped drums cuts a 16-foot swath.

Chopping, like chaining, is only a temporary control since it kills few plants and resprouting soon follows. Therefore, it is only effective when repeated treatment is planned or where other methods are planned to get additional kills. Chopping can be followed by goats to control sprouts for such plants as oaks because the chopping cuts the brush down so that the goats can reach the leaves.

TEX 48-033



The cutting blades on the chopper disturb the soil sufficiently to prepare a fairly good seedbed. Choppers have been used successfully as a seedbed preparation for followup on land previously treated or as additional seedbed preparation on newly rootplowed land to firm up the soil before seeding. A seeder can be mounted on a tractor, as shown here, to broadcast the seed during the chopping operation. Seed boxes are also mounted on top of the choppers.

Chopping has the advantage of being a fairly cheap method, though not as cheap as chaining. Light choppers on small brush cost about \$2 per acre. The larger choppers range from \$3 to \$7 per acre, depending on size of equipment and size of brush being chopped.

Disking

Disking is done with a large disc plow or tandem disc which plows up much of the brush. The method is limited to small, shallow-rooted plants, plowable soils, and to areas having no grass because the plow

destroys any grass that may be present. Due to the limitations, the method is still mostly in the development stage, and only small areas have been so treated. It seems best adapted to seedbed preparation for pasture plantings.

TE-3080-12



Areas being disked must be seeded, but disking leaves the soil in a loose condition undesirable for a seedbed. The plowed area should be compacted with a cultipacker, roller, chopper, or other implement before seeding. The combination of treatments needed makes disking a relatively expensive operation. Cost of disking ranges from \$8 to \$12 per acre. Seedbed modification and seeding will add \$6 to \$10 per acre, making the total cost from \$14 to \$20 per acre.

Mowing and Shredding

TE-2391-2



TE-2761-6



Mowing and shredding are temporary control methods adapted to small-stemmed brush and weeds, and as maintenance or follow-up to control sprouts. It needs to be repeated every year or two for control, or must be followed with goats. Many types of mowers and shredders are used. Heavy duty sickle mowers are adapted to small sprouts. Shredders (left) using a sharp whirling blade, can be used on larger brush up to three or four inches in diameter.

The pasture of the James McCall Ranch (right) near Nocona was cleared of post oak and other woody growth by dozing, and is now maintained by annual shredding.

Brush should be mowed in the spring or early summer before July 1 to get the most effective setback of the plants. Native grass areas should not be mowed after this date because of danger of injury to the grass. Areas of introduced grasses, such as bermudagrass, can be mowed at any time during the growing season, to control weeds and woody sprouts.

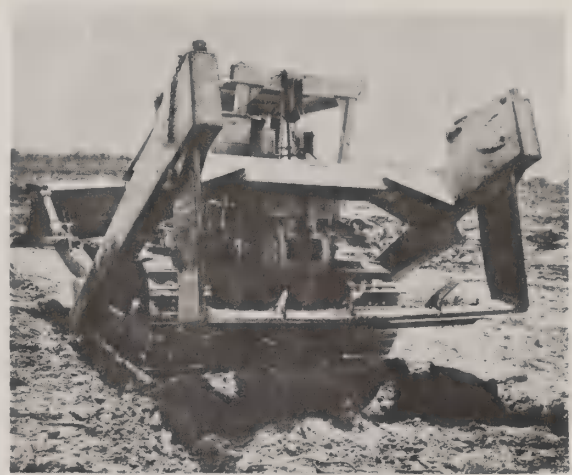
Initial mowing or shredding costs from \$3 to \$5 per acre, and maintenance mowing, if done annually, costs about \$1.50 to \$3.00 per acre. The method is best adapted to areas having a stand of grass where seed is not needed.

Rootplowing

TE-462-3



TE-158-5



Rootplowing, pictured above, cuts off the brush below the ground by means of a horizontal blade pulled behind a tractor, generally at depths of 14 to 16 inches to kill mesquite, and at lesser depths for other brush. The equipment was originally developed for land clearing. The King Ranch was one of the first to adapt it to mesquite control on rangelands. Size of rootplows ranges from small 6-foot blades to 14-foot blades mounted behind double-motored giants that plow up large mesquite trees at the rate of three or more acres per hour. Fins or projections welded to the top of the blade, as shown in the right-hand picture, push the roots up out of the ground to reduce the opportunity for the plant to take root and continue to grow. The fins also break up clods to make a smoother surface.

Rootplowing is particularly well adapted to large, dense brush, chaparral, mesquite too dense for other types of treatment to be practical, and species not affected by chemicals. Rootplowing normally kills 90% or more of the brush unless a heavy rain occurs within one or two days after the plowing operation.

Rootplowing should not be applied on areas having good grass under the brush, for there is a strong probability that the grass will be killed.

The method is best adapted to dense brush areas having little or no grass and where it is necessary to reseed to establish the grasses.

Most effective brush kills are obtained when the operation is performed in hot summer months. However, if seeding is to be done, rootplowing is best done prior to or during the optimum seeding season. Most rootplowing rigs are equipped with grass seeders so that brush control and seeding can be done in one operation. This has worked well in south Texas where blue panicum and buffelgrass are being used, but not as well where native grasses are being seeded. Better stands have been obtained with the native grasses by modifying the seedbed by rolling, chopping, or dragging with a chain to break down the clods and firm the soil.

Rootplowing is an expensive operation, costing \$10 to \$20 per acre, depending on size and density of the brush. Modifying the seedbed will cost from \$3 to \$5 more with seed cost being additional. Thus, a complete job of rootplowing, modifying seedbed, and seeding may cost as much as \$20 to \$25 per acre.

Because of the high percentage of kills, rootplowing will be effective in controlling most brush for long periods. Reinfestation takes place from root sprouts of plants that are missed, or roots not lifted out of the soil, from hard-to-kill species like whitebrush and pricklypear, and from seed. Reinfestation from pricklypear has become a difficult problem in south Texas. Many ranchers are raking and stacking root-plowed brush at a cost of about \$7 per acre in order to clear the land to improve the seedbed, and to make it possible to follow-up for control of sprouts.

..... CHEMICAL CONTROL METHODS

The chemicals most widely used for the control of brush are: oils, ammates, liquid hormone herbicides, and pelletized materials. New materials are constantly being tested; some are extremely promising. The chemical field is one of rapid change, and methods now being used may be obsolete a few years from now.

Results obtained with many of the chemicals have been extremely variable, and on some species, partially or wholly ineffective. Reasons for the variation are not always known. Differences in the nature, application, and concentration of the chemicals, humidity, temperatures, soil moisture, growth stages, and other factors contribute to the erratic results. Experiment stations and chemical industries conduct extensive and continued research on the problems, and improved methods will no doubt be developed.

The subject of chemical treatment of brush is an immense field, and it is not possible to cover more than a summary of the methods, where they are applicable, and benefits in a publication of this kind. State experiment stations and chemical companies have issued publications which contain details of the use of the chemicals. Some of the applicable publications are cited herein.

Oils

TEX 44-761



Kerosene and diesel oil are among the most effective controls for mesquite, huisache, and retama, if applied under proper conditions. They are most effective on open stands of single-stemmed plants when the soil is so dry that a crack has formed around the trunk at ground level.

The oils are applied with a long-spout can, as pictured to the left, or with cutoff valve equipped hoses from a tank, either a small pressure knapsack type, or larger tank mounted on a truck or tractor, as shown in the picture on the following page. From one to two pints of oil are required per plant; enough to completely saturate the base of

the stem above ground level and allow some of the oil to run down the stem to cover the bud zone below ground.

TE-1952-12



Basal treatment of mesquite, huisache, and retama has been the most consistent control, but because of labor requirements and high cost of treating thick stands, is limited in use. The cost will vary from a few dollars to about \$20 per acre for moderate stands. It is generally not applicable to dense stands but is an economical treatment for individual trees and for maintenance and follow-up to control sprouts. Kerosene and diesel oil are also used in mixtures with the hormone herbicides, which are discussed in the section on herbicides.

Ammate

Ammate (ammonium sulfomate) is effective in controlling many undesirable woody plants, but this is an expensive method, probably uneconomical except for scattered trees.

Methods of applying ammate are contained in Texas Extension Leaflet L-413.

Poisonoak and poisonivy are controlled with a foliage spray during the growing season using one pound of ammate crystals in one gallon of water. Blackjack, post and red oak, hackberry, locust, common persimmon, and sassafras can be controlled by filling frills around the trunk or treating the stump with a mixture of three pounds of crystals in each gallon of water. Blackgum, sweetgum, and other hardwoods require a solution of four pounds crystals per gallon of water for

control. Treatment is most effective in fall except for common persimmon and sassafras which are best controlled in spring or summer.

Hormone Herbicides

Hormone herbicides have found wide use as basal treatment and foliage sprays for the control of undesirable woody plants. Three kinds are most often used: 2,4-D, 2,4,5-T, and 2,4,5-TP. Based on research studies, the low volatile esters are more active for control of woody species than are the water-soluble amines and should be used except where otherwise indicated. All spraying work must be done in accordance with county, state, and federal regulations governing the use of agricultural chemicals.

TE-1838-8



TE-1535-12



Basal treatment consists of thoroughly wetting the stem just above ground level, spraying or applying the chemical to a frill or notches in the stem, or by injecting it into the stem with an injector.

Basal treatment is most applicable for scattered trees or where it is desirable to control selected plants and leave others for shade, food, or cover. It is less applicable to many-stemmed brushy plants because of the difficulty in getting to and treating each stem and the large amount of labor and chemical required.

Leaflets 414 and 598 of the Texas Extension Service contain summaries of the most effective basal treatments.

A mixture of eight pounds acid equivalent 2,4,5-T ester per 100 gallons of kerosene or diesel oil is used for most species - mesquite, huisache, live oak, yaupon, lotebush, catclaw, baccharis, Bois d'arc (osage-orange), bitter pecan, cottonwood, gum elastic, hackberry, honey locust, hornbeam, mulberry,

pricklyash, red haw, sassafras, sumac, wild chinaberry (soapberry), and willow.

A stronger mixture of 16 pounds of chemical per 100 gallons of kerosene or diesel oil is required for blackjack, post, red, pin, water and bur oak, ash, blackgum, elm, sweetgum, sycamore, and mescalbean. Coyotillo requires an even stronger mixture of 24 pounds of chemical. Buckeye requires 32 pounds of chemical, but 2,4,5-TP or 2,4-D may be substituted for the 2,4,5-T.

Trees or shrubs less than five inches in diameter are controlled by thoroughly saturating the base of the trunk for 12 to 15 inches above ground. Larger trees should be frilled or notched, as in the pictures, and the chemical applied in the cut. It may be applied to the stump after cutting down the tree to prevent rootsprouting.

A trunk injector has been used effectively on large scattered trees. A mixture of 1.5 pounds acid equivalent 2,4,5-T ester in 4.5 gallons of diesel oil or kerosene. Undiluted 2,4-D amine can also be used. For details, see a new bulletin being prepared by Texas A&M University to be released soon.

When properly applied, basal treatment is generally more effective on mesquite and huisache than foliage sprays. However, because of the labor involved and the necessity for treating each stem individually, it is the most expensive method of applying the chemicals, and is, therefore, more applicable to scattered trees and small groves. The cost of basal treatment ranges from a few dollars per acre to as much as \$20 for dense stands.

The recovery of grasses following basal treatment of oak and other woody growth is often remarkable because of the reduction of competition for moisture, sunlight, and soil nutrients. However, basal treatment is not recommended when reseeding is necessary because the woody growth needs to be removed and a seedbed prepared.

Foliage sprays consist of applying the chemical on the leaves and branches, either by ground or aerial equipment. The method is most adapted to thick brush. Effectiveness depends on the absorption by the leaves and translocation of the chemical into the roots in order to get a rootkill. Unfortunately, it has been erratic in results for reasons not well understood.

Ground equipment ranges from small knapsack sprayers which are used on individual scattered plants or small areas, to large power pump equipment with boom sprayers mounted on tractors or trucks. The chemical is applied through spray nozzles. The boom type sprayers are adapted to large areas where it is possible to get the equipment through the brush.

Ground equipment for spraying each individual plant is most useful for controlling Macartney rose, pricklypear, tasajillo, and cholla cactus,



and lecheguilla because these plants require a thorough wetting of all the leaves and branches to get effective kills. Pricklypear that has been hand-stacked should be sprayed with 2,4,5-T to kill the pads.

Macartney rose is controlled when in scattered stands by thoroughly wetting the leaves and stems with a mixture of four pounds 2,4-D acid equivalent amine in 100 gallons of water. Cost of this treatment is about 70¢ per plant and may total \$14 per acre for stands of 200 plants per acre. Macartney rose that has been disturbed by mowing, burning, or cutting is treated with a mixture of two pounds 2,4-D amine, when treated in spring. After May two pounds low volatile ester 2,4-D in 25 gallons of water should be used. The cost of this is about \$3 to \$4 per acre.

Dense stands of Macartney rose can be sprayed with either ground or aerial equipment using four pounds acid equivalent amine in the spring or three pounds 2,4-D low volatile ester in 10 to 25 gallons of water per acre in the fall. At least two successive applications are needed. Macartney rose is difficult to control, and repeated treatments are necessary. Removal of the dead top growth after the first treatment will facilitate the chemical reaching the stems and sprouts during successive treatments.



Cactus and lecheguilla are killed with a mixture of eight pounds acid equivalent 2,4,5-T ester in 100 gallons of kerosene or diesel oil. It is absolutely essential that all leaves and stems are thoroughly wetted with the chemical to get satisfactory kills.

In Southwest Texas water has been substituted for the kerosene or oil in some trials; results are promising but as yet inconclusive. 2,4-DP was also found 100% effective on cholla in New Mexico. Additional trials are needed for these treatments in Texas to fully determine the practical limits.

Cactus and lecheguilla should be treated when temperatures are above 60° F. The cost of treatment largely depends on the density of infestation, reaching as high as \$30 to \$35 per acre for infestations of 30 to 40% ground cover.

Aerial Spraying

TE-3975-9



TE-2063-12



Aerial spraying has the greatest potential for treating brush infested grasslands that do not need seeding because of the possibility of treating large areas in a short time and at a reasonable cost. Aerial methods can also be used where the infestation is so dense that ground treatment is impossible or impractical, and where mechanical treatment is too expensive. See Texas Extension Leaflet 415 for details of treatment.

Lack of consistent results, the danger of drift damage to nearby crops such as cotton, and the failure to control hard-to-kill species such as whitebrush and condalias, which are components of many infestations, have limited the use of aerial sprays.

Aerial treatment also has the disadvantage of indiscriminately treating all plants. Some of the woody plants are desirable browse, and others are good wildlife food and cover plants. The herbicides also affect many of the forbs, some of which are desirable forage or wildlife food plants. Additional studies are needed to determine the full effects of sprays on such plants.

The reasons for the widely varying results obtained from aerial treatment are not well understood. Aerial sprays have been less effective

and more erratic in the western part of the state where rainfall and humidity are lower. This is no doubt an influence of the low humidity and less favorable growing conditions for plants. It is known that plants should be in a lush growing condition when sprayed to get the best kills. In the western part of the state plants are often in stress for moisture and thereby less susceptible to sprays.

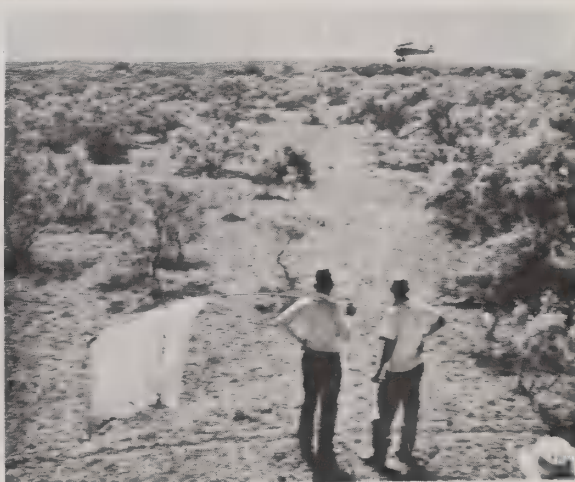
Because of the hazard of drift damage to crops, orchards, gardens, and ornamentals, wind velocities during aerial spraying should never be over 10 miles per hour, and the wind direction must be away from the danger areas. Spray damage has been noted as far as 20 miles when using high volatile chemicals in a high wind. State and county regulations governing aerial spraying must be complied with.

Some industrial chemical companies have developed or are working on an inverted emulsion which produces a spray somewhat resembling mayonnaise so that the heavy droplets fall directly to the earth, thereby reducing drift. The present cost of using this equipment is slightly higher than conventional spray equipment, but the reduction in drift damage may warrant the extra cost if control results are sufficiently effective.

Several types of fixed-wing planes and helicopters equipped with boom sprayers are used for aerial spraying. The spray mixture must be constantly stirred or agitated in order to keep the chemical in suspension so that a uniform application is made.

Flagging, as shown here, or other type of ground control is essential to get complete and even coverage. Aerial application is more effective early in the morning when humidity is high and wind velocities are low, as better coverage can be obtained.

TE-2543-8



Mesquite is controlled with a mixture of 1/2 pound 2,4,5-T low volatile ester in one gallon of diesel oil or kerosene and enough water to make four gallons of mixture per acre. Running type mesquite requires 2/3 pound chemical in five gallons of solution. Mesquite should be sprayed in the spring if current soil moisture conditions are good, the plants are making vigorous growth, and when new leaves are full sized but not yet hardened. This is generally during a period 40 to 90 days after new growth has started. When conditions are favorable one application should result in almost total topkill, but rootkill is often only from 15 to 35%. Follow-up treatment to kill sprouts, either by basal treatment or aerial spraying, is necessary in four to seven years when sprouts are four to six feet high.

Mesquite infested grasslands, having at least a fair stand of grass and not requiring reseeding and no hard-to-control species that will take over, are best adapted to aerial spraying. It is not applicable generally to areas having mixtures of chaparral type species.

Cost of aerial application ranges from slightly less than \$3 per acre, to about \$4 per acre for plane equipment, and about \$1 higher for helicopter equipment. The average annual amortized cost, considering that retreatment will be necessary generally in four to seven years, will run about 60¢ per acre, which is easily justified by the improved growth of grass.

Recovery of grass following control of mesquite has been remarkable in most cases, provided that the grass is given a chance to improve in vigor and cover by resting it from grazing for at least one growing season.

TE-2723-8



Aerial spraying is effective for controlling post and blackjack oaks in large blocks too dense to permit ground treatment as shown in the photo, too costly for mechanical control, and where there is sufficient grass to make satisfactory improvement. These two oaks can be controlled with an emulsion of two pounds of 2,4,5-T ester or 2,4,5-TP (silvex) in one gallon of diesel oil and enough water to make a mixture of four gallons per acre. The oak must be sprayed before the leaves have fully developed, and before July 15. A second application is necessary using 1½ pounds of the same herbicide a year later in order to get most effective control. A rootkill of 75% can be expected with the two successive applications if done under favorable conditions. It generally will be seven to ten years before reinfestation will warrant retreatment.

Aerial spraying of oaks costs about \$6 to \$7 per application, or a total of about \$12 to \$14 for the two applications. Knocking down the dead trees several years after treatment by chaining at a cost of \$4 to \$5 per acre will facilitate control of sprouts; this may be accomplished by shredding, basal treatment, or goating. Burning may be used under the limitations discussed in the section on that subject.

TE-1788-9



Grass recovery following spraying of oaks is generally excellent if the grass is given a chance to grow. At least one growing season deferment is essential to let the grass regain vigor and spread. Joe Rakowitz of Converse in the Wilson Soil Conservation District rested the pasture shown in the photo above for two growing seasons and thereby gave it the optimum opportunity to improve. Little bluestem, purpletop, switchgrass, and sand lovegrass now are dominant where the oaks formerly used all the soil and water resources and there was little forage for livestock.

Sand shin oak, or shinnery, is sprayed with an emulsion of 1/2 pound 2,4,5-T ester or 2,4,5-TP in one gallon of diesel oil with enough water to make four gallons mixture per acre. The spraying must be done when the oaks have developed full leaves in spring and are making vigorous growth. The period May 1 to June 15 is the optimum time statewide, but local adaptations according to seasons must be made. Late spring, frost, or dry conditions causing a delay in spring growth may necessitate a variation or even postponement of the spraying.

Two or three applications in successive years are generally desirable for optimum results, though a single application sometimes results in good control. Two applications may usually be expected to give up to 90% topkill and 40 to 60% rootkill; a third application will usually increase the rootkill to 60 to 90%. The third application is not always justified by grass improvement and because it is not desirable to kill all the oak because of its value for browse and wildlife cover.



Dusan Pakan of the Wheeler County Soil Conservation District sprayed shin oak three times in the pasture shown above, resting it each summer after spraying and conservatively grazing it in fall and winter. Instead of a shin oak thicket, his rangeland now is a grass prairie of little bluestem, sand bluestem, Indiangrass, and sand lovegrass. Prairie chickens have increased notably since the improvement of grass, cover, and food plants.

Aerial spraying of shin oak costs about \$3 to \$4 per acre for each application, or a total of \$6 to \$8 for two applications. Retreatment for reinfestation is generally not needed for eight to ten years. The amortized cost of treatment is about \$1.25 to \$1.50 per acre per year.

Aerial spraying is the most practical method of controlling shin oak because of the large areas infested and the loose nature of the deep sands where shin oak is found, making treatment with ground equipment difficult. However, as for mesquite, some erratic results have been obtained, particularly in the more arid parts of the state, but more information is needed.

The shin oaks common to the limestone soils of Central and Southwest Texas have been controlled mostly with mechanical equipment and goating; chemical control is still in the trial stage.

Sand sagebrush is controlled by a mixture of one pound 2,4-D low volatile ester in one gallon of diesel oil and enough water to make a mixture of four gallons per acre. Soapweed yucca is treated with 2/3 pound 2,4,5-TP in the same amount of oil and water. The plants should be in a vigorous growing condition when treated; yuccas should be sprayed just prior to or at the time the blooms open. Optimum dates are May 1 to June 15 for the sagebrush and 15 days later for the yucca.

Aerial application is the most practical method of treating sagebrush and yucca when in large infestations and there are no nearby crops to endanger. One application is usually sufficient and can be expected to kill as much as 80% of the sagebrush and 65% of the yucca. The cost

will range from about \$2.50 to \$3.50 per acre. Retreatment is usually not needed for eight to ten years.

Macartney rose in dense stands can be controlled with aerial spraying. Methods of control are discussed in connection with foliage sprays on page 19.

MCPA

Whitebrush is a difficult plant to control and requires special treatment. Mechanical control is laborious and costly; basal treatment is difficult because of the dense stands and many stems. The most effective control when in relatively pure stands is a foliage spray either by ground or aerial equipment, using $1\frac{1}{4}$ pounds MCP amine acid equivalent in one gallon of diesel fuel and sufficient water to make eight gallons of mixture per acre. Spraying must be done when the moisture conditions are conducive to vigorous growth and the leaves are fully developed and blooms are present, generally not later than May 15 in spring or earlier than September 15 in the fall.

Spraying should be stopped when the petals begin to shed. Approximately a 30% rootkill with almost total topkill is obtained. It will be necessary to repeat the treatment on the whitebrush in two to three years to maintain control. The cost is about \$5 per acre per application.

Pelletized Materials

The pelletized materials are primarily fenuron and monuron. Fenuron is most effective on coyotillo, post, and blackjack oaks. It should not be used where an understory of hawthorn, beautyberry, greenbrier, and yaupon is present; these plants are not affected and will soon take over. In New Mexico considerable success was obtained with fenuron and monuron on mesquite; these materials have been less successful under Texas conditions.

TE-1920-11



The pelletized material is applied at the base of each plant or is broadcast by hand, cyclone seeder, or by planes equipped with a seed or dust distributor. One tablespoon of pellets per 4" diameter of trees is applied at the base of the plant; five to six pounds of active fenuron per acre are used in broadcast applications. The pellets should be

applied between early February and mid-May when the soil is moist, but not wet.

Treatment with fenuron is high, from \$25 to \$30 per acre or about 5¢ per tablespoon for individual plant treatment. A high percentage of kill is obtained under optimum conditions. However, heavy rains immediately following application will leach the chemical from the soil and reduce the kill. The probability of this happening during the spring months is so great in the more humid portions of the state that fenuron cannot be recommended without reservation for use in controlling oaks.

..... CONTROLLING BRUSH WITH GOATS

TE-1604-8



Goats use browse as a large part of their food if given free choice. Where adapted, they can be used to control low-growing brush, or as follow-up maintenance control of sprouts on brush that has otherwise been treated for initial control. Repeated defoliation of the plant will either control its growth and spread, or kill it if continued long enough.

The following plants can be controlled with goats: live, post, black-jack, bluejack, Texas, water, pin, willow, and shin oaks; sumac, skunk-bush, greenbrier, hawthorn, beautyberry, yaupon, sweetgum, retama, honeysuckle, huckleberry, sassafras, guajillo, blackbrush, trumpet-creeper, and any of the berries. The larger brush and trees must first be cut, chained, or dozed down to enable the goats to reach the leaves and sprouts.

The management of goats is a special problem with which the operator must be familiar if the operation is to be successful. Special goat-proof fences are required, and sheds or protection from severe weather such as cold and rain are necessary. Where the brushy plants are deciduous, winter forage will become short; it is best to use wethers (mutton goats) that can be easily disposed of or moved when the growing season comes to an end.

Predators such as bobcats and coyotes, and occasionally dogs, can do great damage to a flock. Heavy infestations of greenbrier, catclaw, and other thorny shrubs may result in losses of young animals and of mohair which is caught on the thorns.

Best results in controlling brush with goats are obtained by using small pastures to force the animals to remove the leaves and sprouts quickly. A four-pasture system in which grazing can be rotated is usually most practical and desirable. Two to five goats per acre are used, and

sometimes more, the number depending upon the kind and density of the brush. As soon as the woody plants are defoliated in a pasture, the animals are moved to another pasture so that the other forage plants are not excessively grazed.

Successful control of brush will take about three years of repeated complete defoliation, by which time the infestation should be reduced to no more than 15 to 25 percent of the original. Lighter stocking with goats following the three-year period will serve to maintain control of the brush.

TE-277-6



. . CONTROL OF WOODY PLANTS IN RELATION TO WILDLIFE . .

TE - 3567 - 8



TE - 3719 - 2



Woody plants are important as a part of the natural habitat for many species of wildlife as sources of food, nesting and roosting sites, dens, and for cover.

Oak acorns, for example, are an important food for many wild species of birds and animals. The leaves of the oaks are good browse for deer as well as for domestic livestock. Hollow limbs are favored nesting sites for many birds, and dens for squirrels, raccoons, opossums, ringtails, and some other wild animals.

The fruit of wild plums, persimmon, berries, cactus, agarita, hackberry, sumac and numerous other woody plants are important food sources. A large variety of shrubs are browsed by deer; and in fact, this seems to be a requisite for them to thrive. Cactus and lecheguilla are used by deer and javelina and are important emergency foods in time of drought or in winter when other green feed is not available.

Mesquite, guajillo, huisache, blackbrush, whitebrush, and many other flowering shrubs are sources of nectar from which bees make honey. Mesquite and "beebrush" honey are favorites of many people.



Many kinds of wildlife use woody plants as escape cover from predators, and cover is essential to the survival of the young. The fawn in the above photo could never survive without cover and here blends into the grass background.

Trees and shrubs are also primary nesting sites for numerous species of insect-destroying beneficial birds.

Most of the wildlife species (such as deer, turkey, doves, quail, javelina, and squirrels) of particular interest to ranchers because of recreational or income possibilities, adapt themselves to wide variations in environment, though some are more limited than others. Squirrels must have food and den trees, though scattered trees of the right kind are used as well as thick woods. Turkeys must have roosting trees, but can use open grassland as well as woods for foraging.

It seldom is desirable to remove all the woody plants. In addition to the food and cover value, trees serve as shade for livestock. Although livestock can do without shade, research in the southern states shows that most livestock do better if they are provided some shelter from the hot sun.

Leaving some of the brush plants also leaves a source of seed for reinfestation. The landowner has to make a decision in planning his brush control based on the importance of wildlife to him in his operations--what affect removal will have, what and how many of the plants to retain--and then plan for maintenance to control reinfestation.

There is too little specific information regarding minimum requirements for cover and food plants by various wildlife species. Experience and field observations by biologists, ranchers, and conservation technicians do give some worthwhile information that can be used as a guide in planning brush control where wildlife is a definite part of the operation.



Oak and shrubs have been left on the J. C. Stewart Ranch near Johnson City (left) and Texasebony serves as shade on the George Coates Ranch (right).

Most ranchers with deer plan to leave some brush or trees. Different patterns of brush treatment are being used to retain a favorable wildlife habitat. Though authorities differ on how much brush should be retained, most experienced wildlife observers believe that between 10 and 35% of the land should be untreated.



One pattern that is favored by many is to treat brush in strips, usually 400 to 1,000 feet wide, leaving untreated strips 100 to 300 feet, the width depending somewhat on the size and thickness of the brush. The George Coates Ranch in the Starr County Soil Conservation District (pictured above) is an example of the strip pattern.

L. A. Nordan, in the "Hill Country" north of San Antonio, prefers to retain the woody plants on the rough hillsides, controlling them on the deeper soils on the divides which are more productive for grass. Turkey roosting trees are left in the valleys.



TE-4358-9

T. A. McMillan, near Mineral Wells, has cleared the woody brush off the deeper soils and kept the shallow, less productive soils in brush. The mixed grassland and woodland areas here provide the habitat required by most wildlife.



TE-4740-1

Clyde Mayo, near Paducah, seeded grass after controlling shin oak. There is enough cover here for quail, prairie chicken, and other wildlife species adapted to the deep sands of the Rolling Plains.



..... METHODS OF BRUSH CONTROL BY SPECIES

SPECIES	RECOMMENDED CONTROL METHODS	ADAPTATIONS
ACACIA, <u>Blackbrush</u>	(See Chaparral)	
ACACIA, <u>Catclaw and Twisted (Huisachillo)</u> <u>Mimosa, Catclaw</u> Components of Chaparral of S. Texas but also on gravelly and sandy soils, W. and SW Texas	Chaining, chopping Rootplowing Dozing Basal treatment, chemicals	Temporary setback, not generally recommended Dense stands with little grass, for 15-inch and higher rainfall belt. Adapted where scattered plants, small areas Adapted where scattered plants, small areas
AGRITO Gravelly and rocky soils, SW and West Texas	Dozing or hand grubbing Rootplowing Basal treatment, chemicals	Scattered plants, small areas When in dense stands, mixtures with other brush on deeper soils. Adapted scattered plants, small areas.
ASH (See Hardwoods)		
BACCHARIS A common invader into old fields, pastures of Central and East Texas	Mowing, shredding chopping Disking Dozing Rootplowing Basal treatment, chemicals Ground foliage sprays Aerial sprays	Repeated treatment required, 2 to 3 times a year, for 3 to 5 years for effective control. Where seeding is needed. For large plants, scattered or in small areas. For dense stands and where seeding is needed. Scattered to moderate stands, small areas. For controlling small areas, seedlings. Large areas, 50 acres or more, no danger to crops.
CACTUS - <u>Pricklypear and</u> <u>Tasajillo</u>	Grubbing, dozing, raking Railing Disking, chaining, chopping Ground foliage spray	Adapted to small areas, scattered stands, plants should be stacked to decay. Thick infestations, mostly cactus, no large trees present. Temporary control, not generally recom- mended, need repeated follow-up for control. For scattered plants, small areas.

SPECIES	RECOMMENDED CONTROL METHODS	ADAPTATIONS
<u>Cholla</u>	Grubbing, dozing Chaining Ground foliage spray	Small areas and scattered plants Large areas, thick stands. Scattered plants, small areas
CEDARS (See Junipers)		
CHAPARRAL Mixture of many species of South and Southwest Texas	Chaining, chopping, shredding Disking Dozing Rootplowing Chemical methods	Temporary setback; adapted where grasses present, no seeding needed. Effective when followed up with goats, or other treatment, or as initial treatment to knock down brush to facilitate root- plowing Not generally recommended, too many root- sprouting species. Adapted to small areas. Most effective treatment, usually needs to be followed with seeding. Tends to spread pricklypear; whitebrush often re- turns quickly No effective control; not recommended.
CONDALIAS <u>Lotebush, Bluewood</u> <u>(Brasil) Knifefleaf</u> Components of Chaparral of S. and SW Texas, but also understory with mes- quite in West Texas	Chaining, chopping, shredding Dozing or grubbing Rootplowing Basal treatment, 2,4,5-T L.V.	Not recommended Scattered plants, small areas of dense growth In dense stands, and where seeding is needed Scattered plants, single stemmed, small areas
COYOTILLO Poisonous shrub of SW and South Texas	Grubbing, dozing Rootplowing Basal treatment, 2,4,5-T L.V. Pelletized fenuron	Scattered plants When associated with thick Chaparral of South and Southwest Texas Scattered plants Scattered plants
CREOSOTEBUSH AND TARBUSH Desert shrubs com- mon to Trans-Pecos and Southwest Texas	Disking Railing, chopping Rootplowing Chemical methods	Where seeding is possible and practical on good sites. Not recommended where mes- quite present or seeding not practical. Temporary control only used where grass is sufficient to make good recovery. Only where extra water, deep soils, pos- sible to reseed to high producing grasses. None effective

SPECIES	RECOMMENDED CONTROL METHODS	ADAPTATIONS
ELM (See Hardwoods)		
GUAJILLO Common on shallow and rocky soils of SW and South Texas. Desirable to con- trol excessive amounts.	Chaining, chopping, shredding Rootplowing Chemicals	Temporary setback, effective to knock down brush so that goats, livestock can reach browse. Only where component of dense Chaparral and seeding needed. None effective
HACKBERRY (See miscellaneous trees)		
HARDWOODS <u>Ash, elm, blackgum,</u> <u>sweetgum, hickory,</u> <u>red oak, white oak</u>	Dozing Girdling, frilling with basal treat- ment 2,4,5-T L.V. Tree injector Ammate Aerial spraying	For land clearing, scattered trees, and small groves Large scattered trees, small groves. Most effective with basal treatment Large trees, scattered trees or small groves Small areas or groves, and scattered trees Large areas of dense stands, 2 years suc- cessive treatment needed.
HUISACHE Invader in grass- lands of South Texas and Gulf Coast	Dozing, grubbing Rootplowing Basal treatment 2,4,5-T and Kero- sene or Diesel Oil Aerial spraying	Scattered trees, small areas Thick stands with little or no grass, needing seeding Scattered stands, small areas Not effective
JUNIPERS - (Cedars) <u>Redberry</u> <u>Oneseeded</u> Common to rocky soils of Western Texas	Dozing Chaining Rootplowing Chemical methods	Most effective control Not recommended, too many young plants missed Only on deep soils and where seeding is needed None effective
<u>Ashe or blueberry</u> Common on limestone soils of Central Texas	Cutting, axing Chaining	Effective control if all green leaves and stems are removed. Effective for old stands of trees but not for young plants.
<u>Eastern redcedar</u> Common on sandy soils of central and east Texas	Dozing Chemical methods	For scattered plants and small areas. None effective

SPECIES	RECOMMENDED CONTROL METHODS	ADAPTATIONS
LECHUGUILLA An agave of rocky soils of Southwest and West Texas	Grubbing Ground foliage spray 2, 4, 5-T L. V.	Most effective control but expensive Scattered plants on more productive sites
MESCALBEAN (Locally called Mountainlaurel) Evergreen shrub of Southwest and South Texas, usually on rocky hills.	Chaining Rootplowing Basal treatment 2, 4, 5-T L. V.	Useful only to knock down plants so that goats can reach leaves Effective only on deeper soils where seeding needed Scattered plants and small areas.
MESQUITE Common to most of Texas	Dozing, grubbing Chaining Rootplowing Basal treatment- Kerosene, Diesel Oil, and 2, 4, 5-T L. V. Aerial spraying	Effective control only if plants dozed or pulled out below bud zone, scattered trees and small areas Adapted only to tree-type, single-stemmed plants on loose or moist soils so plants are pulled out with roots. Also useful to knock down large trees to facilitate follow-up treatment, such as rootplowing or spraying. Most useful control method where soils are deep and seeding is needed. Also good method where mixtures with other brush. Adapted to scattered trees, small areas. Large trees should be frilled for bet- ter results. Large areas, but where there is little underbrush, and seeding not needed.
MISCELLANEOUS TREES <u>Hackberry, Mul-</u> <u>berry, Pricklyash,</u> <u>Sumac, Soapberry</u> <u>(Wild chinaberry),</u> <u>Willow.</u>	Same treatments as the Hardwoods except aerial spraying is not effective	
OAKS <u>Live</u> Common to Central Texas and South Texas	Chaining Dozing Rootplowing Basal treatment 2, 4, 5-T L. V.	Adapted to dense stands for knocking down trees so that goats can reach leaves Small, dense groves Adapted to live oak thickets of coastal area where seeding needed. Scattered trees - apply in frill or notch

SPECIES	RECOMMENDED CONTROL METHODS	ADAPTATIONS
<u>Blackjack and Post</u> Common on "Post Oak Strip" and other parts of East Texas and Cross Timbers areas.	Chopping, shredding Chaining Dozing Basal treatment 2,4,5-T and ammate Tree injector Aerial spray	For control sprouts or for knocking down small brushy type plants For knocking down trees so that goats can reach leaves and sprouts. Scattered trees and small areas Scattered trees or small groves, larger trees should be frilled or girdled. Scattered trees or small groves Dense woods, large areas. Two years suc- cessive treatments needed, and follow- up to control underbrush by goating, burning, chemical foliage sprays.
<u>Shin Oaks</u> Common on sands of West and NW Texas and to rocky soils of Edwards Plateau, Hill Country and Grand Prairie	Chopping, shredding, chaining Dozing Aerial sprays 2,4,5-T or TP (or ground foliage sprays for small areas)	Used as temporary control to knock down brush so goats can reach it, or to set back brush, later to be sprayed. Adapted only to small areas. Adapted for control sand shin oak in 2 or 3 applications. Trials being developed for control shin oaks of limestone areas.
<u>Red, White, Texas</u> (See Hardwoods)		
PERSIMMON, COMMON AND SASSAFRAS Common invaders into old fields and grasslands of East Texas	Mowing, shredding Dozing, grubbing Basal treatment 2,4,5-T and Ammate	Useful for control sprouts and young plants For scattered trees, small groves Scattered trees and small groves. Apply in frill or to cut stumps for larger trees.
PERSIMMON, TEXAS South and Southwest Texas, often in rocky soils	Dozing Rootplowing Chaining	Scattered plants Only when in dense stands of Chapparral Temporary control to knock down plants so goats can reach leaves.
RETAMA Invader in South Texas and Gulf Coast	Dozing Rootplowing Basal treatment 2,4,5-T L. V.	Scattered plants In dense stands where seeding is needed Most practical treatment

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GRASSLAND

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RESTORATION

Part III - Re-establishing Forage Plants

From This



To This



High producing grasslands are basically important to economic and permanent livestock production. With the cost-price ratio getting ever narrower, the greatest opportunity for livestock operators to meet the squeeze is to produce livestock more efficiently by restoring high producing grasslands.

Forage production, however, on Texas grasslands is far below its potential. About forty percent of the native grasslands of the state are in "poor" condition, having less than 25% of the good forage plants remaining. In the place of the good forage plants, a multitude of undesirable weeds and woody plants are robbing the livestock operators of their soil and water resources, increasing the cost of production, and cutting net returns.

There is urgent need to restore the grasslands to their potential. Grassland restoration must be a four-point program - (1) Control the undesirable brush and weeds, (2) Re-establish the good forage plants, (3) Control sprouts and reinfestation by brush, and (4) Manage grazing to keep the desirable forage plants in a healthy, vigorous growing condition.

This publication, RE-ESTABLISHING FORAGE PLANTS, is the third in a series on GRASSLAND RESTORATION. The first, THE TEXAS BRUSH PROBLEM, presented the magnitude of the brush infestation. PART II, BRUSH CONTROL, discussed methods of control. The fourth in the series will deal with the management of grazing to keep grasslands in high productivity.

Grassland restoration involves all facets of the ranching industry. An all-out approach involving research, finance, education, and technical assistance, as well as unified and cooperative effort by the ranchers themselves through their soil conservation districts and associations is necessary if the problem is to be solved.

The assistance of Dr. C. L. Leinweber, Head, and Dr. Wayne McCully of the Range and Forestry Department, Texas A & M University, in reviewing and making suggestions for improvement of this publication is greatly appreciated.

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Texas

GRASSLAND RESTORATION

PART III - RE-ESTABLISHING FORAGE PLANTS

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GRASSLAND RESTORATION

Part III - Re-establishing Forage Plants

By C. A. Rechenthin, H. M. Bell, R. J. Pederson, D. B. Polk, and J. E. Smith, Jr. - Soil Conservation Service



TE 1826-6



TE 627-11

Which one of the ranges pictured above is making the rancher the best living?

You know the one in the top picture is! Good grass and fat livestock make for profitable ranching.

Yet 40 million acres of Texas rangelands look something like the range in the bottom picture!

The restoration of good forage plants on depleted Texas rangelands is an acute need and essential to maintaining a continuously prosperous livestock industry in the state.

Texas grasslands were once among the most productive in the world. Early explorers and settlers repeatedly described the "unlimited" grazing resources of the state in glowing terms. A large part of the state must have looked much like the range pictured below.



TE 4575-10

White settlers brought their herds and flocks to vast prairies and plains of grass. By 1880, almost the entire grassland area of the state was being grazed. Great cattle empires had been established and fortunes were being made. Millions of cattle that had been produced on the nutritious grasses travelled the famous cattle trails to northern markets.

In the early 80's, a sheep boom brought a tremendous increase in sheep to a large part of Texas. Soon after the turn of the century, it was found that goats thrived on the mixture of browse and grasses, and they became abundant and important in a fast-growing livestock industry.

A significant point is that by 1890, some of the rangelands already were being heavily used. Drought and continued close grazing combined to put a strain on the grazing resources. Livestock operators had little knowledge or understanding of the limitations of use, and thought all that was needed was another good rain! Range deterioration and brush and weed invasion were being noted by observant writers as early as the first of the 90's. This trend of range deterioration has continued to this day on most of Texas grasslands.

It is now estimated by the Soil Conservation Service that at least 40% or about 40 million acres, of native grasslands are in "poor" condition, with less than one-fourth of the good forage plants still remaining. An equal portion is estimated to be in "fair" condition, with one-fourth to one-half of the good plants still present.

Rangeland in "poor" condition may well be called a "sick" range. Livestock operators cannot afford grasslands in poor condition for so little forage is being produced that the range isn't paying its way. Low livestock gains, high feed bills, and death losses reduce the already thin margin of profit to the rancher.



TEX 48727



TE 640-8

A large part of poor condition rangelands are also thickly infested with undesirable weeds or woody plants. The brush survey made by the Soil Conservation Service in 1963 revealed that about 54 million acres are so thickly infested with brush that control is essential to restoration. Much of the brush infested rangeland has enough grass remaining under the brush that with brush control, improvement is possible through conservation management and natural recovery. On many acres, recovery can be hastened with the application of seed. Much of it, however, will need seeding to make satisfactory improvement, as does the range pictured above.

High producing grassland is a prerequisite to profitable and permanent livestock ranching. Restoration of Texas grasslands is a tremendous task facing ranch operators - 54 million acres that must have brush controlled and 20 million that must be seeded; this does not include the millions of acres that would be greatly benefitted by treatment.

NATURAL RECOVERY



TE 2527-10

This pasture on the J. C. Stewart Ranch near Johnson City was cleared of dense cedar. Deferred grazing and proper grazing use have restored the better plants; and the area is a much better range for both domestic livestock and deer.

Livestock operators should first consider the possibilities of restoring forage plants by natural means before undertaking the more costly artificial re-vegetation. Post oak and associated species were dozed in the pasture pictured at the left; and the bluestems were permitted to recover by deferred and conservative grazing.



TE 2355-11

Deteriorated grasslands may be improved by natural means by: (1) development of a soil surface cover to help the soil absorb rainfall, serve as a mulch to promote seed germination and protect and help seedlings to get established, and reduce evaporation, soil temperatures, and surface runoff; (2) recovery of vigor and increase in size in the individual plants already present; and (3) production of seed, germination, and establishment of new plants.



Poor condition ranges usually have little soil cover, are often eroded, and the soil surface is crusted and compacted. This causes high runoff of rainfall - illustrated in the photographs above. A 5.5 inch hard rain wet the soil only about ten inches (left photo), indicating that no more than two inches of the rain were absorbed. The other 3.5 inches were lost as runoff and flooding and also washed out the fences (right photo). Within a few weeks, this pasture was again suffering from drought. Bare soils dry out so readily that only the more hardy, desert-type plants such as annual weeds and red grama can grow.

Sometimes on deteriorated ranges the desirable forage plants are found very thinly scattered or in protected places under brush, between rocks, or in rock crevices. Such plants have generally been subjected to continuous close grazing and are small and weak. They have been forced to compete with the ungrazed weeds and shrubs for soil moisture and sunlight. They are low in vigor, and are likely to succumb to the first unfavorable condition such as drought, if not given a chance to regain their strength.



TE 768-1

A rest from grazing is essential to let weakened plants recover. It is desirable, and usually essential, to defer grazing on rundown rangeland two growing seasons in succession because improvement in plant vigor is greater the second season than in the first. Light grazing during the dormant season may be beneficial in stand improvement. Livestock will trample some of the seed into the ground; this helps to establish new seedlings the following season.

Plants weakened by heavy use and erosion (as the sideoats grama to the left and green sprangletop below) can develop only a few leaves and seedheads. The seed they produce is often low in viability because of low plant vigor.



TE 768-2

Determining areas which can be restored by natural means is somewhat a matter of judgment. It depends on the kinds and amounts of the desirable plants remaining, climate, the rate of recovery that can be expected, cost, and the supplementary treatment that may be used to speed up restoration.

Climate is, of course, a primary factor in rapidity of recovery. Relatively fast recovery can be expected where the annual rainfall averages 25 inches per year or more and sufficient plants remain. The rate of improvement becomes slower as precipitation decreases and is slow indeed under low rainfall. Restoration by either natural or artificial means becomes extremely difficult and hazardous with less than ten inches annual rainfall.



TE 5447-12

Another important consideration is the presence of woody or other competing plants. The mesquite trees at the edge of this field are sapping the moisture from the crops and preventing their growth. Brush does exactly the same thing to grass and young seedlings in a pasture. Competing plants must be controlled if satisfactory improvement of grasses is to be obtained.

It is usually possible to obtain satisfactory recovery by natural spread with careful grazing management where at least ten percent of the vegetation consists of desirable plants, they are uniformly distributed,

and competing weeds and woody plants are controlled. This guide must be considered also in view of the plants to be improved, since some like buffalograss spread rapidly, whereas others like black grama spread slowly. On some ranges grazed extremely short, it is difficult to accurately determine what plants remain, in which case a deferment for a growing season will serve to let the better plants grow so that a clearer determination can be made.

It is sometimes possible to speed up the spread of native plants by supplementary treatment, such as pitting, furrowing, or other soil disturbance that helps to absorb rainfall for seedling establishment. However, such treatments are limited in adaptation, are costly, and are usually temporary. They should be considered and planned with the advice of a technically trained specialist.



TE 28-10



TE 34-6

In left photo, the area shown has been pitted to help hold and absorb rainfall and permit the recovery of the native grasses. The pits are made by cutoff disks on a oneway plow (see right photo). The pits are generally spaced about two to three feet apart, are three to four feet long, and three to four inches wide. Pitted areas can be seeded using a grass seed drill but must be deferred from grazing for a period to obtain optimum results.

ARTIFICIAL SEEDING

Artificial seeding is the mechanical dissemination of seed to establish desired forage plants, which may be adapted plants on rangelands or adapted, introduced, or native plants on permanent pasturelands. The establishment of grasses, such as Bermudagrass, by sprigging is also a widely used method of developing pastures.

Sites That Need Artificial Seeding

Artificial seeding is usually necessary and should be considered when the following conditions exist:

1. Croplands or old fields being returned to grassland. This often includes lands unsuitable for cultivation, such as shallow or sandy soils highly susceptible to wind or water erosion or eroded and "wornout" fields. The 1958 Conservation Needs Inventory for Texas showed that there were 1,826,000 acres of land unsuitable to crops that should be seeded to grasses.



Severely eroded soils (as shown in the photo) are best adapted to permanent grass cover.

2. Open rangelands with none or few of the desirable forage plants remaining. Forty percent of Texas rangeland is in "poor" condition.



TE 28-12

The range pictured here is almost devoid of any good forage plants. The ewe has been poisoned by invading bitterweed which comes on bare ranges. Recovery must be obtained by seeding adapted plants.

3. Brush infested grasslands having little grass remaining, as this rangeland. Fifty-four million acres of Texas grasslands are infested with dense brush, as shown below.



TE 624-5

4. Woodlands having noncommercial trees and being cleared for the development of grazing lands, as illustrated below.



TE 2238-11

5. Critical erosion areas, such as active sand dunes, blow-out spots, or gullied areas.



TE 254-10

6. Dikes, banks, levees, spillways, and waterways which need a protective cover to stabilize them and prevent erosion.



TE 3032-10

The picture shows a waterway where erosion is controlled by a thick cover of grass.

. DEVELOPMENT OF SEED SOURCES

The development of seed sources of the needed and adapted grasses has been no small accomplishment in the conservation history of the state and the nation.

For many years the bulk of the seed used in grass plantings was harvested from native stands.



TEX 46-166

Combines are harvesting prairie grass seed, mostly little and big bluestem and Indiangrass, near Henrietta. Millions of pounds have been harvested from the bluestem prairies.

Below a rancher is harvesting black grama seed with a seed stripper near El Paso.



TEX 46-617C

Harvesting from native stands is a difficult operation. Many grasses, especially in mixtures, mature seed unevenly. Drought, wind, and storms often ruin the seed crop. Seed harvested from native stands seldom met the needs. Black grama in native stands, for example, doesn't set a seed crop but about once in 10 or 15 years in far west Texas.

In order to develop seed sources and test promising plants for conservation uses, the Soil Conservation Service for many years maintained Plant Materials Nurseries, one of which was located at San Antonio. This nursery, abandoned in 1954 for budgetary reasons, produced such well-known and widely-used grasses as blue panicum, buffelgrass, and Uvalde sideoats grama.

KR bluestem was selected and spread from the San Antonio Grass Nursery after it proved promising in an accidental introduction on the King Ranch of South Texas. This photo is of a field of KR bluestem near Pleasanton.



TEX 43-884

Lehmann lovegrass, well adapted in West Texas, was developed on a Soil Conservation Service Grass Nursery at Tucson, Arizona, and introduced into Texas.

The Texas Agricultural Experiment Station and Range Forestry Department of Texas A&M University have also been active in selecting and developing useful plants for range and pasture plantings. Premier sideoats grama and Texas rescuegrass are two species that have been certified and released. A scale-resistant Rhodesgrass, named Bell, has just been released, which may bring this grass back into prominence.

Beginning in 1956 and continuing until 1964, the Soil Conservation Service and Texas A&M University cooperated in the development of planting materials through plant centers at San Antonio and Spur. Numerous species were tested, and seeds of needed varieties were released to seed growers for production of commercial supplies.



TE 1384-B

Several collections of green sprangletop, cottontop, plains bristlegrass (harvesting in top photo), and blue grama were released to commercial growers. In addition, grasses were brought in from other states, tested for adaptation, and released if satisfactory. Several strains of sideoats grama, switchgrass, Woodward sand bluestem (center photo) were found quite well adapted. From this seed a ready supply of needed and adapted grass seed has become available and made possible the many thousands of acres planted in the last few years.



TE 1945-6

Caucasian bluestem, on left in bottom photo, is an introduced species somewhat resembling KR bluestem. It has been found widely adapted to northwest and north Texas for both range and pastureland plantings. It has also been used successfully in waterway plantings.

Arizona cottontop, on right in bottom photo, is a hardy grass adapted to most of west and southwest Texas. It is a native species that should be used more widely in range seedings.



TE 1945-4

The Soil Conservation Service has recently established a Plant Materials Center at Knox City. Broadly speaking, the objective of the Plant Center is to assemble, grow, and evaluate native and introduced plants for conservation uses. Seed of the more promising plants will be furnished to soil conservation districts for field evaluation plantings. Seed of those that prove desirable will be made available through soil conservation districts to growers for commercial production.

. STEPS TO SUCCESSFUL GRASS SEEDING

The Soil Conservation Service and other agricultural agencies have assisted farmers and ranchers in seeding and sodding grasses for many years. Since the establishment of districts in Texas in the early 1940's, soil conservation district cooperators have planted several million acres to grass. About 300,000 acres have been seeded to range grasses in each of the last three years. In this three-year period about 1.5 million acres have been planted to permanent tame pastures, mostly improved Bermudagrass varieties.

The problem of restoring forage plants has been receiving assistance from the various programs of the USDA and the research agencies. Financial assistance has been provided through the cost-sharing provisions of the Agricultural Program and the Great Plains Conservation Program, and through conservation loans by the Farmers Home Administration.

Unfortunately, many of the early plantings and some of the more recent plantings have failed. Many factors contribute to failures, but foremost are lack of rains at the proper time and poor seedbed preparation. Weed competition, insect damage, use of poor quality seed or grasses not adapted, improper methods or equipment, and lack of grazing protection for the seedlings are some other prominent causes of failures.

Weather is still an uncontrollable factor, but methods and equipment have been greatly improved through experience, research, and trials. Grass seeding is at best an expensive operation; it should be planned and applied with the best methods and equipment available and with the advice of qualified technicians.

Failures in grass seeding can be minimized if certain, well-established principles are observed. They are:

1. Use good quality seed of adapted varieties.
2. Develop a weed-free, firm seedbed.
3. Plant the seed at the proper date and depth.
4. Control competitive plants.
5. Defer grazing until seedlings are well established.

1. Good Quality Seed of Adapted Varieties

Seeds of most grasses are relatively small, ranging from about 40,000 per pound to as many as five million per pound. Most species being used in Texas have more than 100,000 seeds per pound. The seedlings from these small kernels have little stored food upon which to start growth and must necessarily send down a vigorous primary root quickly to get established. Use of well-filled, high-quality seed assures good seedling vigor, helpful in getting good stands.

If you want good forage production, always use grasses that are known to be adapted to your soil and climatic conditions. Most grasses have more or less definite limitations as to their soil, climate, and other environmental needs. Weeping lovegrass, for example, does best on deep sandy soils, whereas blue grama grows best on sandy loam to clay soils. Common buffelgrass winterkills north of San Antonio, while orchardgrass and some other cool season grasses can't stand the long hot summers of South Texas.

There are limitations on how far a grass species or variety may be moved to a different environment. For example, blue grama grown in the Dakotas does not do well when seeded in Texas. A species native to an elevation of 4000 feet seldom does well when moved to the 1000-foot level. A species grown under a natural annual precipitation of 30 inches cannot do well at 15 inches. A grass adapted to the heavy soils of the Blacklands usually does not do well in East Texas soils. Grasses adapted to the winter rainfall of the Pacific Coast or the long cold winters of the Northeast cannot be expected to do well under the summer heat and rainfall of Texas.

As a general rule, grasses should not be moved more than 200 miles north or south of their origin, nor more than 100 miles east or west. Generally, they can be moved a little farther toward a more humid or cooler climate than toward warmer or more arid climates. Seed dealers should be able to inform buyers of the origin of the seed. Be cautious of unknown seed or seed of grasses grown under different environmental conditions.

The native grasses, or those growing naturally in your region, are as a rule the best to consider for seeding since they are adapted to the environment. Selections of improved strains of many native species have been made. Introduced species often are subject to disease and other hazards that may take them out, though a few, such as King Ranch blue-stem, weeping lovegrass, Johnsongrass, and Bermudagrass, have become adapted to at least a part of the state.

The table on page 27 lists principle grasses used in Texas and for which seed are generally available, with recommended seeding rates.

Climatic and other conditions vary so greatly in Texas that very few of the grasses listed in the table can be used in all parts of the state. Soil conservation district technical guides and county ACP handbooks contain lists of the locally adapted species with locally adapted seeding rates, optimum dates, and other specifications. These guides should be used for local references.

Rangeland plantings are often seeded in mixtures, using approximately the same ratio that is native to the site. Species in mixtures should be compatible with similar palatability and livestock preferences so that the livestock do not graze one excessively while leaving the other.

Pasture plantings of introduced or native grasses usually are planted in pure stands. Management of grazing so as to get uniform use is difficult where mixtures of grasses are used. A mixture of cool and warm season grasses, though it sounds ideal for year-long grazing, just isn't practical because the livestock will concentrate on one or the other at different seasons, thereby damaging the stand.

2. Weed-free, Firm Seedbed

Following germination, grass seedlings first send out a primary root which serves to hold and feed the plant until secondary roots can develop. If the soil is loose or open, or weedy, the soil may dry out so quickly that the primary root fails to reach moist soil. Wind or grazing animals may pull up the plant. Failures often result from poor seedbeds.

Seedbed preparation for grass seeding is quite different than for cultivated crops. The soil must be firm and free from weeds so that the primary roots can reach moist soil and hold the plants until the seedlings can get established.

Most seedbeds for grass plantings on old fields and croplands being returned to grass are prepared as clean seedbeds, or the seed is planted into a dead litter mulch. The mulch is applied artificially, or a crop such as sorghum or sudan is grown to serve as a dead litter mulch. Rangelands are usually planted using equipment that prepares the seedbed and seeds at the same time, or seed is broadcast or drilled on land on which mechanical brush control has prepared a seedbed. Rangeland seedbed preparation is discussed under seeding methods and equipment.

Clean seedbeds generally involve plowing and disking to produce a well pulverized smooth absorptive surface, free of competitive weeds. This type of seedbed is adapted to planting tame or improved pasture grasses on land to be developed for pastureland. It is also suited to seeding of old fields and cropland being retired to rangeland grasses in the eastern and southern parts of the state where wind and water erosion are not hazardous and rainfall is not a severe limitation. Seedbed preparation should be started several months prior to planting time to permit accumulation of moisture, control weeds, and allow the soil to settle and become firm.



TEX 43-762

A volunteer crop of weed seedlings at planting time can be controlled with disking, in which case it will be necessary to roll or cultipack, as shown, to firm the seedbed.

Grass seed or sprigs can be distributed on clean seedbeds with any of the conventional grass seed planters or spriggers.

Seedbed preparation for clean seedbeds usually costs about \$4 to \$6 per acre.

A non-competitive dead litter mulch consisting of stubble and residue of sorghums, sudangrass, or similar crop has been found most satisfactory for establishing grasses under dryland conditions where wind and water erosion are hazards and where rapid drying of the soil surface and

crusting following rains can be expected. A mulch, either grown as a litter crop, or applied artificially, is essential for reseeding critical erosion areas.

A dead litter crop should be used in converting old fields and cropland to grasslands in the Rolling and High Plains of northwestern and western Texas, in the western Edwards Plateau, and in the western part of the Rio Grande Plains where the grasses are to be drilled.



TE 2594-11

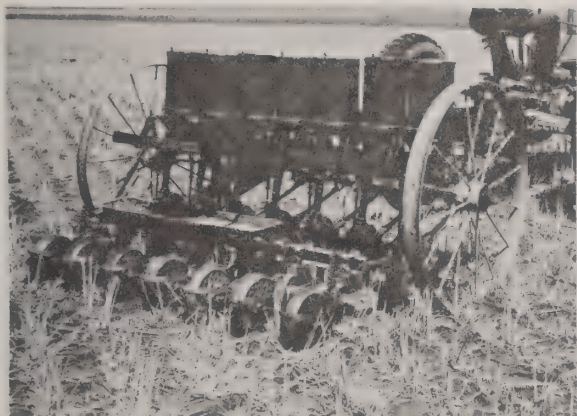


TE 2224-6

The sorghum, sudangrass (photo on left), or other crop to be used for the dead litter is planted using conventional good seedbed preparation for those crops. The crop should be drilled, or if a drill is not available and a row-planter is used, the rows should be spaced no more than 20 inches apart. If the soils are highly susceptible to wind erosion, the dead litter crop should always be drilled.

The principle benefit of the dead litter crop is from the evenly distributed stubble that protects the surface and the grass seedlings. If widely-spaced rows are used, the cover is less effective. Some soil blowing down the rows can occur; also there is more likelihood of wind and sand damage to the grass seedlings. A closely-spaced dead litter crop also helps to control weeds. There is more danger of volunteer weeds becoming a problem in widely-spaced rows.

The crop being used to develop a dead litter mulch should be mowed or shredded to prevent its seed production. Volunteer growth from dead litter crop seedlings will compete with the grass seedlings for moisture and sunlight. The dead litter crop should be mowed or shredded at six to ten inch height and the residue permitted to fall to the ground. An evenly distributed mulch of about two to two and one-half tons per acre is ideal. (See photo on right.) If there are bare spots, they can be covered with artificially applied mulch of sorghum stalks, grass hay, or cotton gin trash.



TEX 1368



TE 2370-1

The desired grasses are drilled into the dead litter at the appropriate time. The soil is generally not disturbed in order to retain the firm seedbed. However, should volunteer weeds become a problem, the area may be lightly disked prior to seeding, followed with a cultipacker to again firm the surface. (See photo above at left.)

The cost of using the dead litter method of seeding is somewhat higher than the clean seedbed method, and at least two years are required. The cost of establishing the grass with the dead litter method will generally range from \$10 to \$13 per acre using average-priced grasses. There is also the loss of the use of the land for the year the dead litter crop is grown.

A dead litter can be artificially applied by spreading hay, gin trash, or commercially manufactured organic material or netting. These methods are much more expensive than growing a crop to use as a dead litter. However, they are more applicable to critical erosion areas, such as gullies, cutbanks, dams, spillways, waterways, levees, blow-outs, or active dunes. About two and one-half tons of mulch per acre are needed. The mulch on steep slopes such as dams and levees can be held in place with netting or tamped into the soil by using an eccentric or special notched disk (photo above at right). The seed can be broadcast or drilled into the mulch.

3. Plant Seed at the Proper Date and Depth

Placement of the seed is important in getting good stands. Grass seedlings upon germination are small and weak. Deep placement will result in failure of the shoot to emerge, or rains will crust over the surface, preventing emergence. Don't plant grass seed the same depth as cultivated crops. Grass seed should seldom be planted deeper than $3/4$ inch, and usually no more than $1/4$ inch. The seed should be firmed into the soil to prevent too rapid drying out of soil and to assist the primary root to reach firm moist soil. Grass seed should not be planted down in the bottom of a furrow, for heavy rains will too often wash soil over the seed, covering them too deep for emergence.

4. Control Competitive Plants

Most grass seedlings are relatively slow in getting established because the seeds and plant seedlings are so small. Weeds and volunteer crops such as wheat, grain sorghums, or sudangrass grow rapidly and will compete seriously with the grass seedlings for moisture. Reduction or

prevention of competition is important for successful seeding. Mowing, shredding, or chemical herbicides are useful in controlling undesirable plants. Grazing to control weeds is seldom beneficial, and may be quite harmful, because the livestock will usually select the young grass seedlings, pulling many of them out.

5. Defer Grazing Until Seedlings Are Well Established

Many grass plantings have been ruined by grazing too early. Cattle graze by wrapping their tongues around the stem and leaves, and break them off. New seedlings or young plants, particularly those on loose soils, are very susceptible to being pulled up by grazing livestock. Even horses and sheep, though they bite off the leaves, tug as they bite and pull up many plants not firmly rooted.

Removing the leaves by early grazing also prevents food manufacture and full development of the new plants. Livestock tend to seek out the new seedlings because the fresh green growth is generally high in proteins and very palatable. Continued removal of the leaves will result in starvation and eventual death of the plants.

Newly seeded grasses must not be grazed until the plants are well established. Many of the native species of tall or mid grasses such as the bluestems and sideoats grama grow slowly and should be allowed to grow for all of the first growing season. If weather conditions are unfavorable, or if the grass is slow in getting started for some other reason, it will be desirable to rest a second growing season, with a little light use permitted during the dormant season. Many of the introduced species, such as buffelgrass, blue panicum, KR bluestem, and Bermudagrass, have been selected for seedling vigor and rate of growth, and may be grazed as soon as well established. This is generally about the time the first seedheads are developed.

If only a part of a pasture needs treatment or is suitable for seeding, livestock will tend to concentrate on the treated area. The whole pasture must be deferred, or temporary fences may be used to hold off livestock from the treated area. It is often practical to treat only pastures where one-half or more is adapted to treatment, using natural recovery to improve pastures where this is not possible.

Management of grazing following seeding often determines the ultimate success or failure of a seeding. All other steps can be perfectly executed, but heavy use of the seedlings can cause a seeding job to fail.

. SEEDING METHODS AND EQUIPMENT

Grass seed of different species vary greatly in characteristics. They vary in size from kernels almost as large as wheat grains, to very small, having as many as five million per pound. Regardless of size, the seed of all range and pasture grasses adapted in Texas have a common planting requirement - they should not be placed in the ground deeper than 3/4 inch. Most grow best when planted about 1/4 to 1/2 inch deep.

Some grasses such as the lovegrasses and dropseeds have clean, free-flowing seed units that are relatively free of chaff, and can be readily planted with vegetable-type planter boxes. Cracked grain such as grain sorghum is sometimes mixed with small grass seed to make it possible to use planting equipment adapted for large seed. Only a few grasses such as Dallisgrass have seed large enough to plant with grain planter equipment.

Many of the grasses do not have clean seed units, the seed being enclosed in one or more bracts, which may be hairy, cottony, awned, or a bur. The bluestems and cottontop have hairy or cottony seed. Texas wintergrass seeds have stiff awns which curl and twist, making them difficult to plant. Buffalograss and big cenchrus seed are enclosed in a bur. Special treatment is required to prepare such seed for planting; this treatment is given by the seed producer or dealer. Cotton planter mechanisms or adaptations thereof, or broadcast distributors are required to distribute chaffy seed at the desired seeding rates. Buffalograss is sometimes treated to remove the burs, preparing clean seed that can be distributed with the vegetable-type planters.

A wide variety of grass planting equipment has been developed for use under many different planting conditions. Some types of equipment are available from implement dealers, and some are shop-made.

Often it is not practical to purchase or rent equipment for seeding small areas or for only a field or two. Many soil conservation districts have available seeding equipment that can be leased. Custom contractors with seeding and sprigging equipment are found at many places; this may be the most practical method since they have the right kind of equipment and are experienced in handling and distributing the seed. Most of the men engaged in mechanical brush control have their machines equipped with planters so that seed can be distributed during the brush control operation at little or no extra cost.

Grass planting operations can be grouped into five principle methods, depending on the planting materials and equipment used and the kind of seedbed preparation involved. They are:

1. Seedhay and mulch seeding.
2. Drilled seeding.
3. Broadcast seeding.
4. Row planting.
5. Sprig planting.

Seedhay and Mulch Seeding

Grass plantings made by spreading hay that contains seed of the desired species is an effective method for establishing grass on small eroding or critical areas. Nearly the same results can be expected where seed

is applied to the area following an application of mulch material that does not contain any seed (see photo below). In either case, the hay provides a mulch cover that holds soil moisture near the surface until seedlings become established. From one to two and one-half tons of seedhay or mulch per acre are needed, with the larger amount preferred on the more critical areas. Usually little seedbed preparation is necessary or desirable because of the erosion hazard. The mulch material must be spread evenly; on steep slopes it will need to be secured in place by some means. Fibrous netting is sometimes used; or the mulch material may be tamped into the soil by means of a sheep-foot type roller or with a disk plow with eccentric or blunt disks (see page 17).



TE 1683-5

Because of the hand labor required in spreading the hay and the cost of hay, the seedhay method is generally too expensive except for treatment of such areas as gullies, dams, spillways, some waterways, dunes, and blow-outs. Hay of a quality suitable for mulch, whether or not it contains desirable grass seed, may cost from \$20 to \$30 per ton. The cost of spreading usually about equals the cost of the hay. Commercially prepared organic mulches cost a little more than hay mulches but are less laborious to apply.



TE 322-3

Commercial organic mulches which can be applied by special spraying or spreading equipment are also on the market. The seed is mixed and spread with the organic mulch.

Drilled Seeding

When the ground surface will permit the use of special grass seed drills, range and pasture plantings usually result in better stands than from any other grass seeding method, except cultipacker seeding on good seedbeds.



Grass seed drills feature either a hopper fitted with picker wheels, as the drill in the picture above, or individual cotton planter boxes to distribute chaffy seed, and a set of vegetable planter boxes to handle clean, free-flowing seed. One of these small planter boxes can be seen on the left behind the hopper. The drill in the above photo is being pulled behind a pitter made of a disk plow which is preparing a seedbed on open rangeland.

The spring loaded disk furrow openers, seen under the drill above, are equipped with depth gauge bands that insure proper seed placement. Furrow spacing of these drills ranges from 9 to 12 inches, depending upon the type of planter mechanism used in the assembly of the machines.

At right is another grass seed drill, which uses the cotton planter boxes for the chaffy seed. The small clean seed vegetable boxes are mounted between the cotton boxes. One can be seen under the man's arm.





TEX 48-701A

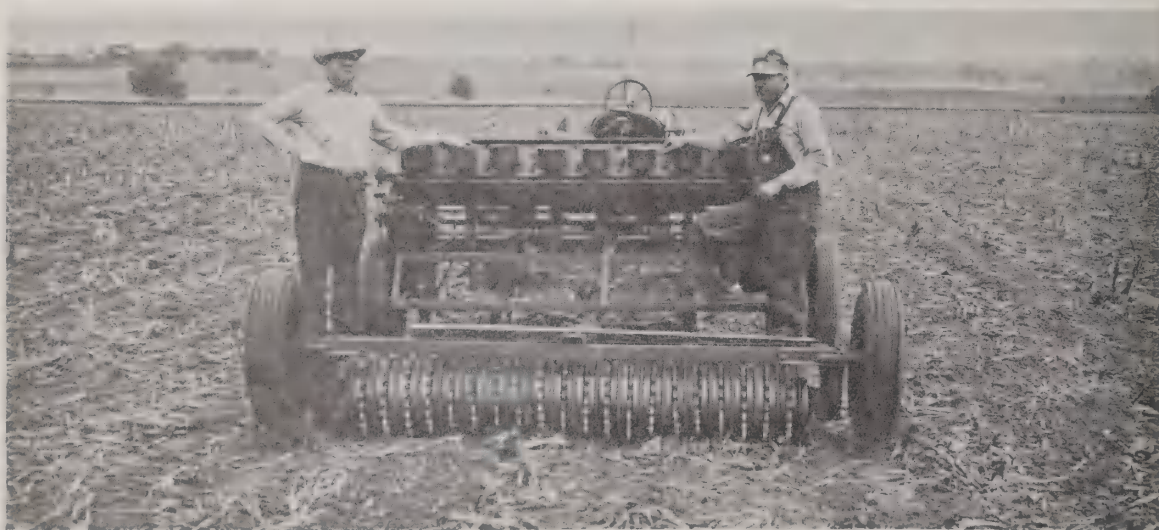
At left is the rear view of a grass seed drill, showing the row of small vegetable boxes for clean, small, free-flowing seed.

The short grasses, such as blue grama and buffalograss, should be drilled. Tall grasses may be drilled or row-planted. Grass seed drills can be used on clean tilled land or in dead litter mulches. Drills can

also be used on overseeding rangelands free of obstructions such as land that has been cleared of timber or rootplowed land that has been raked. Some sort of soil disturbance for seedbed preparation is needed in addition to the furrows made by the drill for overseeding open rangeland not having mechanical brush control.

Broadcast Seeding

Broadcast seeding must be used in conjunction with most mechanical brush control work, unless the area is cleared of woody material so that drills or planters can be used. Broadcasting is also acceptable for planting on clean seedbeds provided some sort of packer can be used to press the seed into the soil.



TE 2390-6

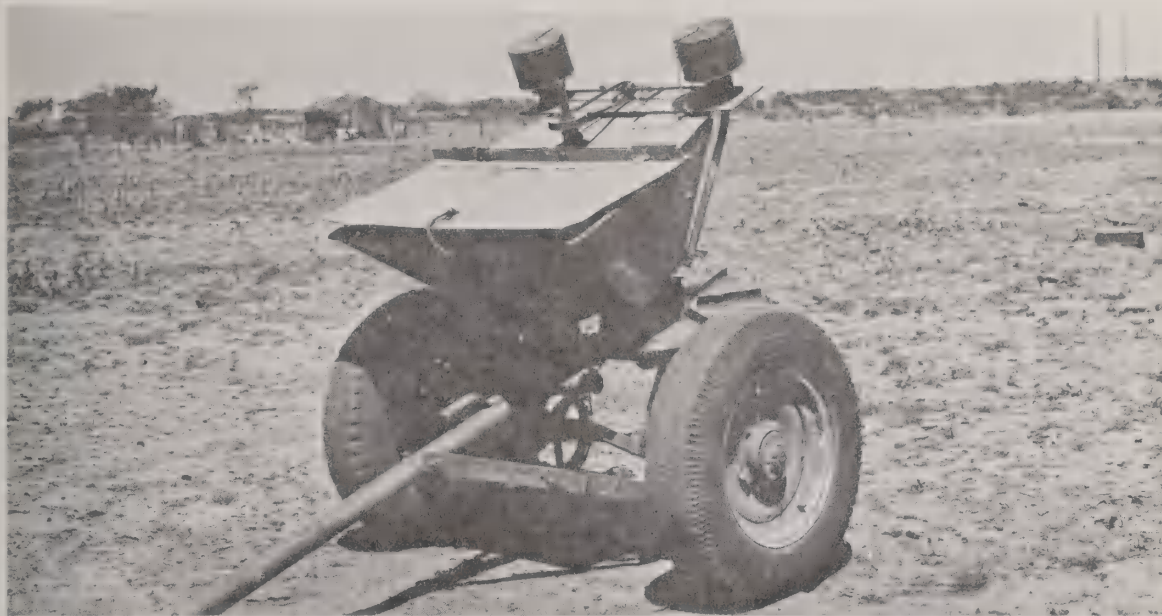
The cultipacker type of seeder is the most successful method of broadcasting.

It is important to get a uniform distribution of seed on the ground whether it be broadcast by hand, whirlwind, or fan-type spreader, from an airplane, or from ground equipment. Broadcast seeding is seldom effective without some soil disturbance ahead of the seeding operation. Rootplowed land having large clods or extremely rough surfaces should be smoothed and firmed with a chain, drag, chopper, or rake before seeding.

In broadcast plantings along with rootplowing, the seed should be made to fall either behind the plow blade or to the side on ground plowed the

previous round. The same seed placement should be made when seed is broadcast on land disturbed by rolling chopper or brush stacker. It is satisfactory to drop seed ahead of a rail or chain drag.

There are many kinds of seed broadcasters, ranging from shop-made rigs to more expensive commercial implements. And, of course, the seed can be broadcast by hand, a method that is as old as agriculture.



TEX 48-749

Pictured is a lime spreader equipped with vegetable seed boxes for small grass seed. Seed falls on the ground. This type of seeder should be followed with a packer to firm the seed into the surface.

In the bottom photo, sections of pipe with ends closed and with lids cut into the top are mounted atop the rake. This rig is used to broadcast seed while raking brushland. Holes have been drilled along the bottom of the improvised seed boxes and fitted with wires. The movement of the rake shakes the wires, letting seed fall out.

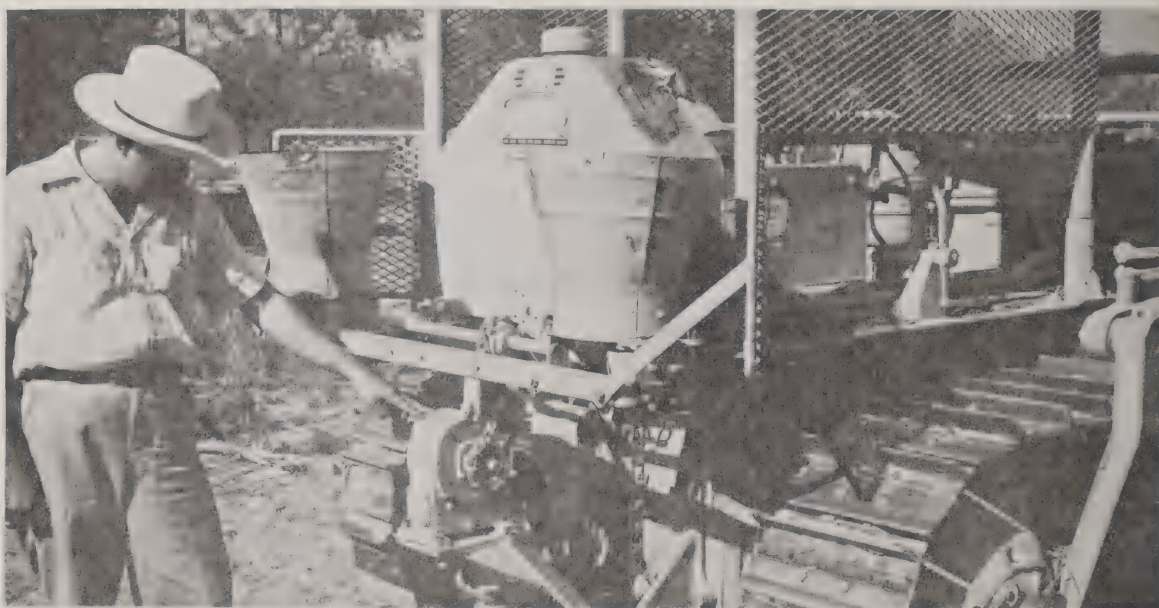


TE 1715-6

Top photo is of seedboxes mounted on a tractor with power takeoff that drives fans beneath the boxes, scattering the seed ahead of a chopper or other type of brush equipment.

Bottom photo shows the more common method of mounting seed boxes on the back of the tractor. This is a new improved type of seeder which has boxes for both chaffy and small clean seed. The seed drops into a pipe; the exhaust, which is turned into the pipe, blows the seed to the rear. The seed should either drop behind the root plow or onto land that has been plowed the previous round.

Somewhat similar mounts are made where an electrically-driven fan scatters the seed to the side of the tractor on land previously plowed or treated.



TEX 48-034



TE 2268-9

Row Planting

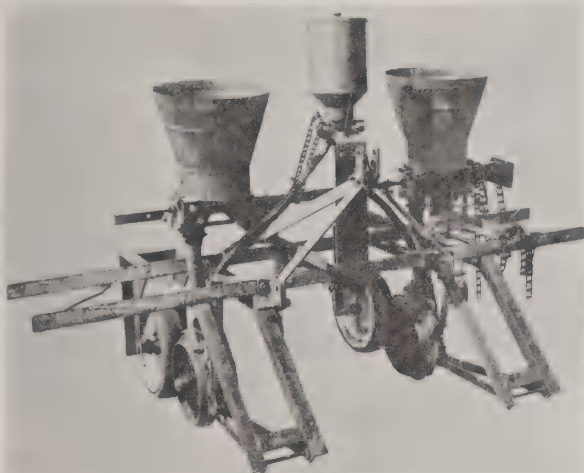
Grasses planted for tame pastures and seed production on dryland where it is desired to fertilize and otherwise cultivate the grass at times, are usually planted in rows. Many of the taller growing rhizomatous grasses planted on rangeland may be planted in rows because they will fill the intervening space.



TE 2010-2

Weeping lovegrass is planted here in rows. Row planting permits cultivating, fertilizing, and easier seed harvesting.

Row plantings of grass are usually made on clean-tilled seedbeds so that weeds can be controlled by cultivation. Row plantings may be made in dead litter mulches if weeds are not expected to be a problem or can be controlled with herbicides.



TE 86-5

The best equipment for row plantings employs the same disk furrow openers and planter boxes for clean and chaffy seed as used on seed drills, except that they are usually mounted on tool bars or frames and have about the same row spacing as for cultivated crops grown on the farm.

In the center photo is a two-row planter showing the large boxes for chaffy seed and the smaller box in the middle for small, clean seed. This is a planter developed at the old San Antonio Soil Conservation Service Grass Nursery. Important features are the depth gauge bands on the furrow openers and the packer wheel to firm the soil around the seed.



TE 28-11

In the bottom photo is a commercially manufactured three-row planter that uses both sizes of boxes and the depth gauge band. It is being used here to seed pitted rangelands. The furrow openers are spring mounted so that they will rise and fall with the surface of the soil, always placing the grass seed at the proper depth.

Sprig Planting

Bermudagrass, African stargrass, and several others are planted by "sprigging", placing the rhizomes (underground runners or "sprigs"), in a furrow. They may also be planted by seed, (those that produce seed - Coastal Bermudagrass and stargrass do not), or they may be planted by planting the stolons (surface runners), or by sod. Planting the stolons is less practical because they must be planted quickly and may dry out before they take root. Buffalograss, as well as Bermudagrass, is sometimes planted with chunks of sod; but because of cost this method is generally only practical for small areas such as lawns.



TE 2471-4

found in many soil conservation districts. These contractors will do a complete job, furnishing the sprigs and doing the planting at a flat rate.

Bermudagrass pastures are increasing throughout Texas and have been found to furnish high quality forage. However, to get satisfactory results, like those on the dairy farm in the photo below, the area must be given maximum attention - fertilizing, weed control, and management of grazing so the grass is kept in healthy growing condition. High returns don't come from low quality management!

Bermudagrass sprigs should be planted in a weed-free, well-prepared seedbed. Sprigs can be planted in the winter or spring months. Local guides should be consulted for the best time. The major consideration is to get the sprigs planted early enough that they can take root before hot weather dries out the seedbed.

Several equipment manufacturers make spriggers; some are home or shop-made, as shown at right below. Local contractors are



TE 1746-7



TE 3484-12

SEEDING RATES FOR GRASSES IN TEXAS

The table below lists the most common grasses planted in Texas and their recommended seeding rates for row, drilled, or broadcast seedings as adapted.

GRASS	POUNDS PLS AC.		POUNDS COMMERCIAL AC.	
	NORMAL ROWS	BROADCAST OR DRILLED	NORMAL ROWS	BROADCAST OR DRILLED
Bahiagrass	-	-	-	12.-16.
Bermudagrass (Sprigs)	-	-	8-10 bu.	16-24 bu.
Bermudagrass (Seed)	-	-	1.-2.	2.-4.
Bluestem, Angleton or Medio	.3-.5	.6-1.	-	-
Bluestem, Big and Sand	1.5-2.	.3-4.	-	-
Bluestem, Cane	.4-.6	1.25-2.	-	-
Bluestem, Caucasian	.3-.5	1.-1.5	-	-
Bluestem, Gordo	.4-.6	1.-1.5	-	-
Bluestem, Kleberg or KR	.3-.5	1.-1.5	-	-
Bluestem, Little or Native Mix.	1.-1.5	2.-4.	-	-
Bluestem, Pretoria 90	.4-.6	.7-1.	-	-
Bristlegrass, Plains	1.2-2.*	2.7-4.*	-	-
Brome, Smooth	-	-	-	10.-14.
Buffelgrass	1.-1.5	2.-3.	2.-3.	3.-5.
Buffalograss (Bur)	1.6-2.*	4.-6.*	-	-
Buffalograss (Grain)	-	-	.5-1.	1.-2.
Cottontop, Arizona	.3-.4	1.-2.	-	-
Dallisgrass	-	2.5-4.	-	-
Dropseed, Mesa or Sand	-	.9-1.2*	-	-
Fescue, Tall or Meadow	-	-	-	10.-14.
Grama, Blue	.4-.7	1.5-2.	-	-
Grama, Black	.5-.8	1.-2.	-	-
Grama, Sideoats	2.-3.	4.-6.	-	-
Indiangrass	1.5-2.	3.-4.	-	-
Johnsongrass	-	-	5.-7.	12.-20.
Kleingrass	.5-.7	1.5-2.	-	-
Lovegrass: Lehmann, Sand, Weeping or Wilman	.5-.7	1.-2.5	.6-1.	1.2-3.
Orchardgrass	-	-	-	10.-14.
Panicum, Blue	.8-1.	1.6-2.	1.-1.5	2.-3.
Pappusgrass, Pink and Whiplash	.75-1.	2.25-3.	-	-
Rhodesgrass	.3-.5	.7-1.	1.-1.5	2.-3.
Ryegrass, Perennial	-	-	-	10.-14.
Sacaton, Alkali	.25-.4	.75-1.	-	-
Sorghum alnum	-	-	5.-7.	10.-15.
Sprangletop, Green	.5-.7	1.5-2.	-	-
Switchgrass	1.-1.5	3.-4.	1.5-2.	4.5-6.
Trichloris, 2 and 4 flower	.3-.5	1.-1.5	-	-
Vine-mesquite	1.5-2.*	3.6-5.*	-	-
Wheatgrass, Western	-	-	3.-4.	8.-10.
Wintergrass, Argentine	.3-.5	1.-1.5	-	-
Wintergrass, Texas	2.-3.*	6.-8.*	-	-
Wildrye, Canada	-	-	6.-8.	12.-16.

*These rates are based on "Pure Seed" rather than PLS.

Seeding rates are based on a guide of about 20 seed units per foot of row, or per square foot. Rates for some species are adjusted to what experience has shown is required to get satisfactory stands. Rates

shown in the table are those required for re-vegetating old fields, cropland, and depleted rangelands. For re-vegetating critical or erosion hazard areas, the rates should be doubled, except for Bermuda-grass; for this grass the broadcast rate generally will be sufficient.

Seeding rates are shown in two columns, one as "Pounds PLS" (pure live seed), and the other as "Pounds Commercial Seed."

Most grass seed is now sold on a "pure live seed" basis. Seed material of many grasses contains considerable chaff and bits of stems and varies widely in seed content. This is particularly true of seed such as the bluestems and gramas; these seeds are enclosed in bracts and cannot be cleaned to pure seed or kernels. For this reason, it is best to handle them on the actual content of live seed or "pure live seed" basis.

Some grass seeds are slow to germinate, having a period of dormancy after ripening; they require aging or weathering before germination will take place. These grasses are sold on "pure seed content," rather than "pure live seed" because of the delayed germination. They are shown with an asterisk in the table.

Free-flowing, clean seed (such as the lovesgrasses, and grasses such as the panicum and wheatgrasses) are easily harvested and cleaned so that a uniform, high purity is obtained; these seed are sold on "commercial material" basis.

Grasses that have seeding rates listed under both PLS and commercial columns may be handled on either basis. However, pure live seed is always a more accurate measure of quality of seed.

"Pure live seed" is determined by making a purity count and a germination test under controlled laboratory conditions. Multiplying the percent of pure seed or purity by the germination percentage will give the "pure live seed." For example: a seed testing 20% purity and 80% germination equals a pure live seed content of 16%. In other words, in each 100 pounds of seed material there are 16 pounds of pure live seed.

If the pure live seed content and the seeding rate are known, it is easy to determine the total amount of seed material or how much per acre to seed by substituting in the formula:

$$\frac{\text{Total pounds PLS}}{\text{PLS percent}} \times 100 = \text{pounds seed material needed}$$

Example: 100 acres are to be drilled to sideoats grama, with seed testing 30% purity and 70% germination: $30 \times 70 = 21\%$ PLS

The table shows seeding rate of four pounds per acre PLS
100 acres to be seeded $\times 4 = 400$ lbs. PLS needed

$$\frac{400}{21} \times 100 = 1900 \text{ pounds seed material, or 19 pounds per acre}$$

Purity determinations are made similar to the PLS except that only the percent purity is used instead of purity times germination.

SUMMARY

Re-establishing the forage plants by natural or artificial means is a necessary step on millions of acres of Texas grasslands to restore their productivity. Brush must be controlled on 54 million acres, and at least 20 million acres must be seeded to get satisfactory improvement.

Seeding of grasses is an expensive operation and weather and other hazards may cause a planting to fail. Methods and equipment have been greatly improved through experience. Failures can be minimized by using the best adapted methods. It is necessary to use good quality seed of proven species, planting at the optimum time for local conditions. Soil Conservation Service Work Unit Technical Guides and Agricultural Conservation Program County Handbooks contain lists of locally adapted species and methods.

After seedings are made, success is possible only if grazing is carefully managed to permit the seedlings to get established. Many seedings have been destroyed by too early or too heavy grazing.

Any successful operation for grassland seeding must be preceded by a carefully developed plan which is then carried out step by step. The hazards incurred in grass seeding make this particularly important. The assistance of experienced technicians made available through soil conservation districts should be utilized to plan for and restore grasslands to their fullest productivity.



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Which side of the fence are you on?



.....management makes the difference.

GRASSLAND RESTORATION

Part IV - Grassland Management

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, TEMPLE, TEXAS
January 1966

Much has been written of the history of Texas grasslands. Early historians and pioneer settlers optimistically described the almost limitless 'seas of grass' which appeared to them as a never ending source of wealth. Much has also been written of the decline of this once great grassland as a result of droughts, social and economic changes and man's mismanagement.

We are aware of the cold, hard facts that low value or worthless woody plants have replaced much of the grass on about 54 million acres of Texas grassland and that these plants are spreading on additional millions of acres. We know, too, that at least 80 percent of our native grazing lands are now producing less than half the high quality forage plants they are capable of growing.

We are rapidly becoming aware, also, of the increasing demands made on our grasslands for wildlife and recreation and for water management. It has been said that a dependable yield of high quality water for our farms, cities, and industries may become the most important product of much of our land now in grass. USDA economists expect domestic and export requirements for livestock products to be at least 50 percent higher by 1980 than they are today. Our exploding population, and that of the entire world, places an increasing demand on the products of our grasslands. The livestock producer is constantly seeking ways of reducing costs of production in face of the ever tightening cost-price squeeze under which he operates. The need for grass and other livestock forage is in sharp contrast to that for some cultivated crops. There is no surplus of grass now.

If the present condition of our grasslands is the best we could ever expect it to be, the demands being placed upon them could never be met. But, fortunately, this is not the case. The demands of the livestock producers, the sportsmen, the recreationists and the water users alike can all be met through the restoration and wise use of our grasslands. It still rains as much as it used to (contrary to many 'old timer' reports) and we still have most of our precious soil. Most Texas grasslands CAN be restored to a much higher level of productiveness if we will but give them the treatment and care they need.

The first of this series of GRASSLAND RESTORATION publications pointed to the size and nature of the Texas Brush Problem. Part II described methods for control of unwanted brush on the 88 million acres now needing such treatment. Part III gave detailed procedures for revegetating some 20 million acres of former grassland which now have too little of the original grass cover to permit economical natural restoration. This publication, Part IV of the series, treats the essential need shared by ALL grasslands - that of proper use and management.

Neither brush control, revegetation nor any other treatment will result in optimum improvement and profitable sustained returns from our grasslands unless accompanied by and followed by the kind of management which provides for the needs and requirements of the plants, soil, and water of those grasslands.

The assistance of Drs. C. L. Leinweber, E. J. Dyksterhuis and Donald L. Huss of the Range and Forestry Department, and Garlyn Hoffman, Extension Range Specialist, of Texas A&M University in reviewing and making suggestions for improvement of this publication is gratefully acknowledged. Appreciation is also expressed for use of certain photographs which they furnished.

H. N. Smith

H. N. Smith
State Conservationist
Soil Conservation Service
Texas

45 868

GRASSLAND RESTORATION

PART IV - GRASSLAND MANAGEMENT

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GRASSLAND RESTORATION

PART IV - GRASSLAND MANAGEMENT

BY HOWARD B. PASSEY, WITH ASSISTANCE OF H. N. SMITH, STATE CONSERVATIONIST,
MEMBERS OF THE STATE PROGRAM STAFF, AND FIELD SPECIALISTS

INTRODUCTION

In 1872, John James Ingalls wrote: "The primary form of food is grass. Grass feeds the ox; the ox nourishes man; man dies and goes to grass again. Grass yields no fruit in earth or air, and yet should its harvest fail for a single year, famine would depopulate the world."

The grass Ingalls wrote about includes the great food crops - wheat, rice, corn, sugarcane, sorghum, millet, rye, barley and oats - and it also includes the many kinds of forage grasses which provide pasturage and much of the cured feed for all types of farm and range livestock and for multitudes of wildlife.

Just as food crops are essential to the world's human population, grass is essential to the Texas livestock industry, to its wildlife and to the entire Texas economy. The highest type of land use for over 100 million acres of this state is the production of grass for grazing. It has been estimated that grass furnishes over 80 percent of all cattle feed in the state. Except for small amounts of protein supplement, most Texas range livestock subsist almost entirely on grass until they are shipped to the feedlot or packing plant.

Grasses are the plants best suited for growing on vast areas of our grazing lands. Some kinds grow in our hot, dry deserts, others in the higher, cooler uplands, and still others in the humid lowlands. Some grasses grow during cool weather, others only during warm seasons. Some live only one season, while others are perennial - living several years. Some kinds grow tall while others form close-growing sods. Some grasses are very palatable and nutritious but others are of little grazing value.

Within Texas there are many different kinds of soils and wide differences in the amount and seasonal distribution of rainfall. There are differences in temperature,



Some grasses, like this black grama, are adapted to the dry, desert-like conditions of this Hudspeth County ranch.



Others grow best
in the Plains
country.



And still others
in the more
humid wooded grasslands.

TE 1035-12

humidity, wind and other features of climate. Thus, there are many different kinds of grasslands. Mother Nature, in her wisdom, has provided the kinds of plants best suited for growing on each of these different kinds of grasslands.

Grassland plants are really quite hardy - they endure a reasonable degree of drought and flooding, disease, insects, rodents, fire, and use by livestock and wildlife. They have the ability to renew and reproduce themselves. But they are still living things, and as such, have definite requirements for soil, water, air, sunlight, and for a place to grow.

Plants have their own "food factory" in their leaves. Here they manufacture food to feed themselves and to feed our grazing animals. Healthy, thrifty grass plants are wonderfully efficient machines. They can convert the raw materials of the soil and air into nutritious food. They produce the cheapest livestock feed available. Economic limitations dictate that the Texas livestock industry be based upon this cheapest of all sources of high quality feed.

Grass and other good forage plants are the CROP on grasslands. Livestock merely provide a good way to harvest this grass crop and of changing it into livestock products. Grass goes to market on the hoof or in a sack in the form of beef, lamb, wool or mohair - or even in the form of hunting leases. Thus, the real measure of

Grass goes to market
in the form
of livestock.



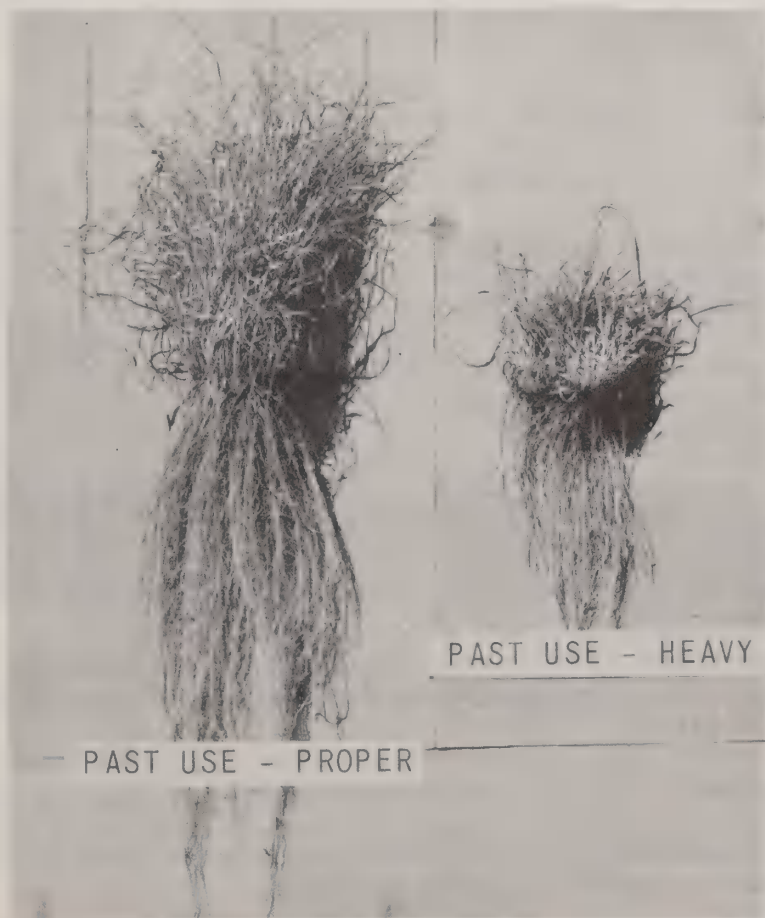
production on our grasslands is not the number or quality of livestock we own, nor even the number of acres we control, but the amount and quality of grass we produce and how we use that grass.

In order to manage our grassland plants for best production, we need to know a lot about them. We must know the needs of these plants, how they grow, how they feed themselves, how and when they reproduce, how they compete with each other, and how they will respond to the kind, time, and amount of grazing use we may give them. If we know these things about our plants and so pattern our grazing use to meet these needs, we are then helping Nature to grow all the feed that our grasslands are capable of growing.

This publication is prepared to help all users of Texas grasslands gain a better understanding of the basic fundamentals of grassland restoration through wise use of this great resource.

HOW PLANTS GROW

The two grass plants shown on this page were taken from a seeded grassland pasture on the same day in early spring. They were dug from the same drill row - within a few feet of each other. They were the same age, grew in the same soil, had the same amount of rainfall, and both were protected until they were well established. Then a fence was built to divide the area into two pastures. For the next few years, the



pasture represented by the plant on the left was properly grazed. The other pasture was heavily grazed.

Notice that the plant on the left has much more early growth - important when calves, lambs, kids and fawns need the extra milk their mothers produce from lush feed. Notice also the difference in the size of the roots of the two plants. By the end of the growing season, the pasture represented by the plant on the left had produced a total of 1,500 pounds of air-dry foliage per acre, while the other pasture had grown only 300 pounds per acre.

Young calves,
lambs, kids,
and fawns need
the milk their mothers
produce from
early green grass.



TEX 41,456

Why did these differences in growth and production take place? To best understand this, we should take a close look at how plants grow.

Many people believe plants get their food from the soil. But this is not true. If we were to analyze a sample of soil, we would find no proteins, no starches or sugars, no fats - in fact, no food. What we would find, however, are minerals such as nitrogen, phosphorous, potassium, lime, sulphur, iron and several others. These are "raw materials". When water is available and temperatures are favorable, the plant absorbs these minerals and water through its roots. It then moves them up into its leaves where, with energy furnished by the sun, these raw materials are combined with air and "manufactured" into food. Actually, about 95 percent of the total plant comes from carbon and other elements which the plant takes from the air. The green part of the plant, then, is the "food factory." This is the only place where food is actually manufactured. (Animals do not make food - they merely change it from one form to another.)

PLANTS MUST FEED THEMSELVES

What happens to the food manufactured in the plant leaves? A part of it goes right back into the roots which gathered up the raw materials. Here it "feeds" the roots so they can grow larger. It repairs damages which may have taken place. Much of the food is used to grow new roots because perennial grass plants replace about half their roots each year.

Part of the manufactured food is used for growing more leaves to increase the size of the "food factory." Part is used to produce stems and seed so the plant can reproduce itself. In addition, a part of the food manufactured in the leaves is returned to the plant roots in the form of stored plant food.

This stored food is very important to the plant. This is the food it uses to keep alive during the winter or during other non-growing periods. This is also the food the plant uses to start growth in the spring. In the cooler climates, plant leaves dry up in the fall of the year and the plant is "dormant" for several weeks or months. Then, when moisture and temperature are right for growth, the plant has no "food factory" as yet, so it draws on the food reserves it stored up the year before to send up its first green leaves. (Some plants go dormant during hot or dry weather and they, too, must have stored food to enable them to begin growth again.) If the first few leaves are clipped or grazed off, the plant must dip into its root reserves again to replace these leaves. If the leaves are repeatedly clipped, the plant soon runs out of root reserves and simply starves to death.

From this discussion, it should be apparent that the plant must be able to "feed itself" if it is to stay alive. Fortunately for the livestock industry, strong, healthy plants are able to produce more food than they need to feed themselves. It is this surplus growth that we can harvest with our livestock and wildlife.

HOW MUCH GRAZING USE?

We might compare a plant with an animal. If we put a steer in the feedlot and feed him a "maintenance ration," he will not gain nor will he lose weight - he will stay just about the same. If we feed him a little more than a maintenance ration, he will gain weight. But, if we feed him less than a maintenance ration, he will lose weight and, if he is underfed long enough, he will starve to death.

A plant does the same thing as the steer. It has a "maintenance ration," too. If we leave only enough top growth for maintenance, the plant will just maintain its



- a. This little bluestem plant has been very lightly grazed with only the tops of the seedstalks and a few of the leaves used. It can stand more use.
- b. This plant is properly grazed. About half the top growth has been left. With this amount of use, it will stay thrifty and productive.
- c. This plant is slowly starving to death because too much of its leaf growth has been grazed. It will produce very little forage and may not make it through a dry year.

present size. If we leave a little more top growth, it will gain in size and productivity (up to the maximum size of that kind of plant in the place it is growing). But, again like the steer, if we leave less than a "maintenance ration" of top growth, the plant may stay alive a long time but it will gradually get smaller and finally will starve to death.

The amount of top growth needed to properly "feed" the plant varies somewhat with the kind of plant, the conditions under which it grows, the season it is grazed, and several other factors. Most good forage plants, however, need about half their top growth to keep them healthy and productive. The other half can be safely harvested with animals. As a rule-of-thumb, then, we might say "take half and leave half" - and we might continue "and both halves will get bigger."

If we apply this rule-of-thumb to the two plants in our first example, we could have safely grazed 750 pounds per acre (50 percent of 1,500 pounds) from the pasture represented by the plant on the left. This would have been about two and one-half times as much as we could have obtained from the other pasture even if we had grazed it right to the ground and had used all of the 300 pounds per acre it produced.

Healthy, vigorous, "well-fed" plants always grow larger than weak, "under-fed" plants. And half of a large plant is always more than half of a small plant - and often more than all of a very small plant.

THE HALF WE LEAVE TO FEED THE PLANT

Suppose we agree that we should leave half of the top growth to feed the plant during the growing season. After heavy frost in the fall or after any other dormant period begins, the half we left has dried up and has died. It is no longer needed to feed the plant. Why not go ahead, then, and graze this half, too?

Actually we can safely graze a little more than 50 percent of the top growth if our plants are healthy and if grazing is only during the dormant season. But the half we left to feed the plant is still working. It still has several other "jobs" to do. The part we leave becomes stubble, or litter, or mulch. This ungrazed growth becomes an "air-conditioning system" for the plant. It protects the crown of the plant - the tender, growing portion with its new growth buds - from extremely cold temperatures during winter, and acts as a sunshade during hot, sunny weather in summer. Mid-summer temperatures are as much as 30 degrees cooler in a plant crown protected by stubble than one exposed to direct sunlight. This stubble also shields and protects seedling plants while they become established.

Most everyone has noticed that when a leaf drops from a broadleaved tree or shrub in the fall of the year, there is a tiny bud on the twig where the old leaf was attached. Inside this bud is next year's new twig with its new leaves and new blossoms. These buds were formed toward the end of the growing season and are ready to start growing as soon as it warms up next spring. Grasses form this kind of buds, too. Grass buds are located down in the crown of some of the short-growing kinds of grasses, but may be two or more inches above the crown on the more productive bunch grasses. Naturally, if grass stubble is grazed below the point where the new buds were formed, the buds are destroyed. It may take several weeks of the next year's growing season for the plant to grow new buds and to begin rapid leaf growth again.

If we lose this best part of the growing season, we lose much of our forage production.

In the High Plains country we often have "horizontal" snow storms with much drifting, blowing snow. A good cover of grass stubble traps much of this snow and holds it until it melts and runs down along the plant roots into the soil.



Moisture in the snow trapped by this grass stubble will grow forage next year.

TE 2960-6

Plant mulch on the ground helps reduce evaporation of soil moisture. Drying winds "suck out" tremendous amounts of moisture from bare soil. Litter helps to keep the wind from touching the soil and greatly reduces this loss.

Our torrential rains have a great deal of power as they strike bare soil. Raindrops pound and pack the surface so it seals over and hinders water from entering the soil. These drops also gouge out soil particles which then wash away with the runoff water. Raindrops striking a plant leaf or stem are robbed of their power to pack and erode the soil. A good mulch cover is the best insurance against soil and water loss.

This highly magnified photograph shows the power with which raindrops strike bare soil.



C-2079

Anyone who has irrigated knows that the longer a stream of water runs on a farm field, the more of it soaks in until the soil is full. This is also true on grasslands. A good mulch cover provides dead leaves and stems which act as billions of miniature dams to slow down the water following a storm. The more it is slowed down,

the more it soaks into the soil - and the more there is for plants to use to make feed for animals.



TE 5622-12



TE 5522-3

A five inch rain penetrated only six inches where the soil surface was bare (left above), but the soil was wet to more than 18 inches nearby where a good cover of grass and mulch helped the water into the soil.

As plant mulch finally breaks down and decays, it becomes a part of the soil. It adds organic matter that makes the soil more like a sponge so it will absorb water more readily and will hold it longer for the use of growing plants.

We can do little or nothing about the amount of water that falls on our grasslands. But we can do a great deal about how much of it stays there where it is needed. If we get 20 inches of rainfall but lose half of it to evaporation and runoff, we are then trying to grow grass on only ten inches of moisture. It is the amount of rain we KEEP that counts. The same plants which feed our livestock and wildlife also offer the best possible way to keep our moisture.

The water running off into this gully will grow no grass. A good cover of grass and mulch would have helped it get into the soil where it would have grown useful forage.



The stubble we leave is not wasted feed. It is an investment in next year's feed crop - and in the crop for many years to follow. It is a good investment which pays off in increasing amounts of high quality feed, a more dependable water supply, and a more secure grassland industry.

ROOTS AND TOPS

If we look at our two plants once more, we note that the plant on the right has a small top AND a small root system. The other plant has a large top AND a large root. There is a direct relationship between roots and tops. A small top just cannot feed a large root. Neither can a small root system reach enough water and minerals to supply a large top growth.

Research studies have shown that when 90 percent of the foliage of a growing grass plant was clipped, root growth was completely halted for 17 days, and only 60 percent of the roots was active after 33 days. With a single clipping of 50 percent of the foliage, however, only two to four percent of the roots stopped growing and these for only about 14 days. Studies also showed that properly grazed blue grama grass had roots to a depth of four feet. Heavily grazed blue grama roots reached only two feet in depth, and almost all of the roots of severely grazed plants were within the upper one foot of soil.

The importance of a big, healthy root system is obvious. The extensive roots can reach more soil moisture and raw materials for the use of the plant. During dry years, plants with large root systems can usually reach enough moisture to make some livestock feed. Plants with small root systems may do well to stay alive during drought, let alone make any feed.



A large, healthy root system enables this grass clump to draw water and nutrients from a large area of soil.

Plants are always competing with each other for moisture. Good forage plants with large root systems can use the moisture "away from" weedy plants. Forage plants with small roots must "share" their water with inferior plants. If we are to increase our good forage plants on our grasslands, we must give them every advantage possible to permit them to compete successfully with weeds, brush, and other less desirable plants.

DIFFERENT KINDS OF GRASSLANDS

Because of the many differences in climate and kinds of soils in Texas, there are many different kinds of grasslands. These different kinds are usually referred to as "sites." For example, an area with deep, coarse sandy soil would be a "Deep Sand" site; one with very tight clay soil would be a "Clay" site; very stony land may be included in the "Shallow" site, etc. On a single ranch, or even within a pasture, there may be two or more different sites.

This "Shallow" site in Val Verde County is producing all the good quality forage its shallow, stony soils will support.



R - 4 - 1142



Most grasslands originally had a mixture of good forage plants. Some were tall with deep roots, others were shorter with shallower roots. Some plants grew in cool weather, others only in the summer.



On some sites the original plant cover was an open stand of trees with nutritious grasses underneath.

Over the centuries, Nature developed a mixture of plants which was best adapted for growing on each site. This mixture usually included some deep rooted, tall growing plants and some shorter, shallower rooted kinds. Some plants in the mixture grew in cool weather, others mostly in the summer. The mixture was such that some kind of plant was growing most of the time except during very cold weather. On some sites, the mixture included trees with a layer of grasses underneath. Other sites had an original cover made up almost entirely of grasses. Still other sites contained a scattering of browse plants (shrubs) along with grasses and forbs. (Forbs are non-woody plants other than grasses. They are often called "weeds," but many are very valuable forage plants.)

This original mixture of plants fitted the soil and climate so perfectly that other kinds of plants could not move in. This kind of plant cover is called the "potential" plant cover for the site. So consistent is Nature that even on depleted areas we can quite accurately predict what the "potential" plant cover is if we know the soil and climate.

The "potential" plant cover on grassland sites is almost always the kind that produces the largest amount of high quality livestock feed the site is capable of growing.

CHANGES IN GRASSLANDS

Had the original cover remained thrifty and vigorous, it would still be much like it was a century or more ago. However, only a small percent of the grasslands of Texas are now growing the same kinds and amounts of plants they originally supported. Many changes have taken place. On some lands, the present cover does not even resemble the original or "potential" cover. Former tall grass prairies now have only short grasses, brush, and other low-value plants. Thick stands of trees and brush now cover many acres on which originally were only scattered trees and dense grass. Other areas are virtually bare except for short-lived annual weeds during "wet" years.

The cover
on this shallow
site has been reduced
to poor quality
grasses, weeds,
and brush.



TE 3866 - 3



The plant cover
on this "Sandy" site
is a thin stand
of poor grasses
and scattered shrubs
instead of the tall
grasses which
used to grow there.
There is too
little cover
to keep the soil
from blowing away.

When the grasses
she intended to grow
on this land
were killed out
by misuse, Nature
replaced them
with pricklypear
and worthless brush.



TE - 299 - 8

Why have such changes taken place? The answer can be summed up in one word - COMPETITION. Plants are continually competing with each other for moisture, soil nutrients, sunlight, and space in a battle for survival. The plants most successful in this competition are those that are "well-fed" and vigorous. Many things, including drought, insects, fires, or disease helped to upset the balance and tip the scales of competition in favor of certain kinds of plants. But man and his livestock played the major role in this upset.

Even within the original plant mixture, all plants were not equally palatable to grazing animals. They eat the most palatable kinds first. When these are grazed and no longer available, they eat the next most palatable and leave until last the kinds they prefer least. If a pasture is too heavily grazed, the most preferred plants are grazed again and again until they become weakened and are no longer able to reproduce themselves.

The better plants are always hurt most from heavy use. For example, if a plant that normally grows 30 inches tall is grazed within two inches of the ground, perhaps 90 percent of its leaves (food factory) has been removed. On the other hand, if a short growing plant that normally grows only eight inches is grazed to the same height, only half or less of its top has been removed because most of its leaves are close to the ground. Thus, the short grasses can escape some of the damage from close grazing the taller plants cannot avoid - but the short grasses are much less productive.

Nature tries to prevent "vacancies" in plant cover. When the most palatable plants begin to "starve out", they are replaced by other kinds of plants which are either much less palatable to animals or, like the less productive short growing kinds, are better able to escape too-heavy grazing use. If misuse is long continued, even the less preferred kinds of plants lose out in competition and are replaced by still less



When the original grasses on this Sutton County pasture were grazed out, they were replaced by poisonous bitterweed.

TEX 49, 167

useful kinds. This is why high producing, nutritious plants on many grasslands have been replaced by invading weeds, brush, trees, spiny, thorny or poisonous plants and by bare ground. Invading plants do not make up for losses in forage production because they are too often of little or no grazing value - or furnish forage for only a short season. And, needless to say, with too-heavy use, plant litter is reduced, more water is lost to runoff and evaporation, and less water gets into the soil.

Not only are most invading plants of little grazing value, but they are also inefficient users of soil and moisture. While grasses need only 400 to 1,000 pounds of

Thick stands
of brush are not
only poor forage
but are also
heavy users
of limited soil
moisture.



TE 299-7

water to produce a pound of dry forage, shrubs and trees require 1,700 to 2,400 pounds to grow a pound of leaves, twigs, and bark. Mesquite, a notorious water waster, needs over 1,700 pounds of water for a pound of growth, while the valuable sideoats grama grass needs only about 700 pounds. Thus, invading brush with its widespread roots, robs the better forage plants of the moisture they need to grow feed. Brush also shades out many kinds of grasses by cutting off their needed supply of sunlight.



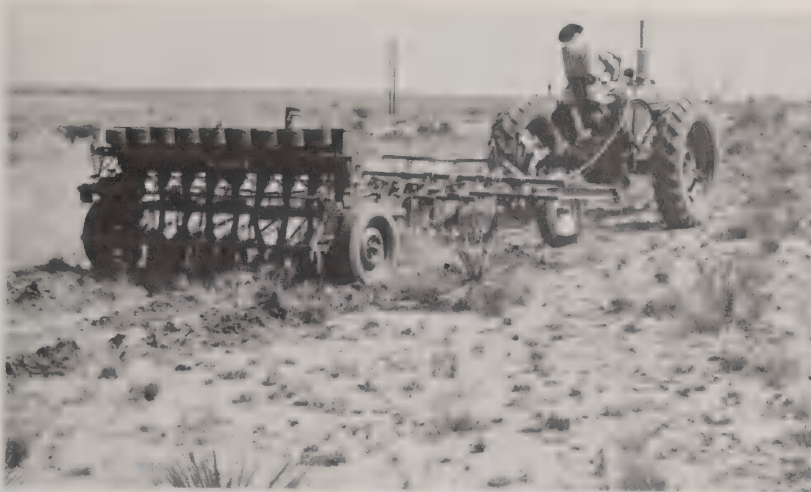
Soil has blown away
revealing the roots
of this mesquite tree.
Such a large
and widespread
root system
could compete with
grass for soil
moisture over
a large area.

TE 254-9

In addition to the competitive effects of brush, it also adds to livestock handling problems and increases costs of production of livestock products. The right amount of good quality browse plants, of course, can be an asset. They furnish high quality feed for some kinds of livestock as well as feed and cover for wildlife.

IT WILL COME BACK, TOO

It is often said that the cause of a problem suggests its cure. If grasslands deteriorate because of improper grazing use, then they should build back toward their potential plant cover under conditions of proper grazing use. Fortunately, this is true. Nature always tries to put back the kinds of plants the land is best suited to produce. But Nature needs a lot of help. The longer and more seriously a plant cover has been deteriorated, the longer it takes to bring it back to high production.



When too few good grasses remain, it often pays to speed up grassland restoration by artificial revegetation.

TE 1224-11

This rolling brush cutter will slow down brush growth to give grasses a chance to re-establish themselves.



TEX 46,825

If there are few remaining plants of the potential plant cover, it may be profitable to artificially revegetate an area to speed up its improvement. If woody plants have gained a foothold, it often pays to give Nature a boost by controlling the brush so grasses will have less competition in re-establishing themselves. But without the proper kind of grazing use, neither revegetation nor brush control will result in lasting improvement. In fact, no grassland plant cover will improve in quality and production unless the right kinds of plants are given a chance to grow and increase.

"KEY" PLANTS

The simplest way to restore productivity and quality of grasslands is to allow the "key" plants to grow and reproduce. On any grassland, including those artificially revegetated, some kinds of plants are more important in the potential than others. These are the "key" plants. A "key" plant is one which is capable of growing a large amount of high quality forage on the site where it is growing, and one which the landowner wants to increase on his land. For example, if there were equal amounts of little bluestem grass and threeawn grass (needlegrass) in a pasture, the little bluestem would be the "key" plant because it is more productive and makes higher quality forage.

The key plant is used as a sort of "yardstick" for grazing a pasture. We should apply the "50-50 rule" (graze no more than half the top growth) to the key plant to permit it to increase in the mixture and to help it crowd out the weedy plants. If the key plants are properly grazed, the entire mixture of plants will not be over-used.

Sideoats grama, the darker grass on the left foreground, is the "key" plant in this pasture. Note how cattle and goats have grazed it much more closely than the curlymesquite on the right. If grazing continued until the curlymesquite was properly used, the more valuable sideoats grama would be severely damaged.



TEX 44,777

The kind of key plant may be different if grazing is during the winter than if the pasture is grazed in summer. For example, Texas wintergrass might be the plant on which grazing use is based during winter grazing, but some good summer-growing plant like little bluestem would be the key plant if grazing is during the summer. Likewise, the kind of livestock or game animals using the grassland would help determine which was the key plant for management. If the landowner wished to increase the number of deer on his place, for instance, his management must favor those plants which are most important as deer feed. The key plant, then, is one which is important in the potential and also important to the kind of animals.

The "50-50 rule" does not apply to all of the plants in a pasture - only to the key kind of plant. If a pasture is grazed until half of all the forage is grazed, the more palatable kinds will have been seriously overused. Underuse of the less palatable kinds of plants will not make up for overuse of the kinds we are trying to increase. If heavy use is permitted on the key plants, the other plants which are only lightly used or not used at all are given the advantage in competition and they, rather than the key plants, will increase.

A good rule is to watch what is happening to the key plants.

FITTING KINDS OF ANIMALS TO KINDS OF PLANTS

Some kinds of plants are readily eaten by all kinds of grazing animals. Other kinds of plants, however, are more palatable to some kinds of animals than to others. Sheep will eat some plants which cattle leave alone unless they are forced to eat them. Cattle will consume coarse grasses which sheep and goats do not like. Goats and deer relish some kinds of browse which neither cattle nor sheep eat unless other feed is lacking.



TE 1826-6



TE 2753-5



TE 2753-9

Some grasslands are best suited for cattle, some for sheep and some for goats. Many grasslands can be most efficiently grazed by all three.

For these reasons, grasslands growing a variety of plants can often be most economically and efficiently grazed by combinations of different kinds of animals. Such grasslands should be stocked with kinds of animals that are in proportion to the kinds of forage available. This does not mean, of course, that they be fully stocked with each kind of animal because there is always some "overlapping" in use of many plants. A combination of stock, however, will often permit range improvement and efficient use at the same time.

Studies at the Ranch Experiment Station near Sonora show that pastures there were more productive and net returns were greater when they were grazed by a combination of kinds of animals than when stocked with only one kind. Depending on the kinds of forage available, some pastures are best utilized by cattle and sheep, others by cattle and goats, and still others by cattle, goats, and sheep.

Proper management of grazing by livestock need not interfere with production of wildlife either. Again at Sonora, it was found that there was a very close relationship between intensity of grazing and the number of deer in a pasture. Deer abandoned the heavily grazed pastures (except those used only by cattle) but sharply increased on moderately grazed pastures. Deer compete more with goats and sheep for forage than they do with cattle. With hunting leases becoming more valuable, it is often very profitable to adjust kinds and numbers of livestock using the grasslands to favor those plants on which deer depend. Increases in returns from hunting leases often more than make up for any temporary decrease in livestock numbers. Sportsmen are increasingly willing to pay attractive sums for hunting privileges on lands which support an abundance of well-fed game animals.



TE 5015-10

Deer are a valuable product of many grasslands. They furnish recreation for sportsmen and income for landowners.

DISTRIBUTION OF GRAZING

Livestock are lazy. They repeatedly graze convenient areas close to water, salt, bedgrounds, shade, and loafing places. Only when the plants they prefer are eaten from such places will they go farther away. Sheep and goats tend to graze into the wind and will often overuse the end of a pasture from which the prevailing wind comes. Cattle try to avoid rough, steep, or stony land while sheep and goats use such areas more readily. Although deer use level, open grasslands, they like to spend much of their time in the protection of brush, trees, or rocky ledges.



Livestock are lazy.
They often severely
over-use areas
around water
or loafing places
while other parts
of the same pasture
are under-grazed:



TE 1538-6

Because of these grazing habits, if there are any over-used areas in a pasture they are around places of animal concentration. Often it happens that part of a pasture is severely over used while another part is actually under used because of poor distribution of grazing. Light or non-use of part of a pasture will not make up for too-heavy use of another part.

Some problems of grazing distribution cannot be completely corrected, but many can be. Developing watering places in parts of a pasture which have been under used helps take the grazing load from areas too heavily grazed. Cross-fencing to reduce pasture size can help if pastures are too large or if they include two or more kinds



Properly located
stockwater developments
help in getting
good distribution
of grazing in pastures.

TE 1467-6

of land which animals do not use to the same degree. Wherever practical, cross-fences should follow the boundary between different kinds of grassland. Salt and minerals should be placed at a distance from water or on sites animals normally do not graze enough. This helps to entice them into such areas and, thereby, to pull them away from parts of the pasture which have been used too much. Protein supplements fed during winter months should never be placed in areas where livestock naturally concentrate - for to do so will only encourage still heavier use of forage plants on such areas.

Cottonseed cake
and salt should always
be placed in
lightly grazed
parts of the pasture
and away from water
or other
concentration areas.



TE 3855-8

Changes in season of grazing and in kinds of livestock often help in getting the proper amount of use more uniformly within pastures.

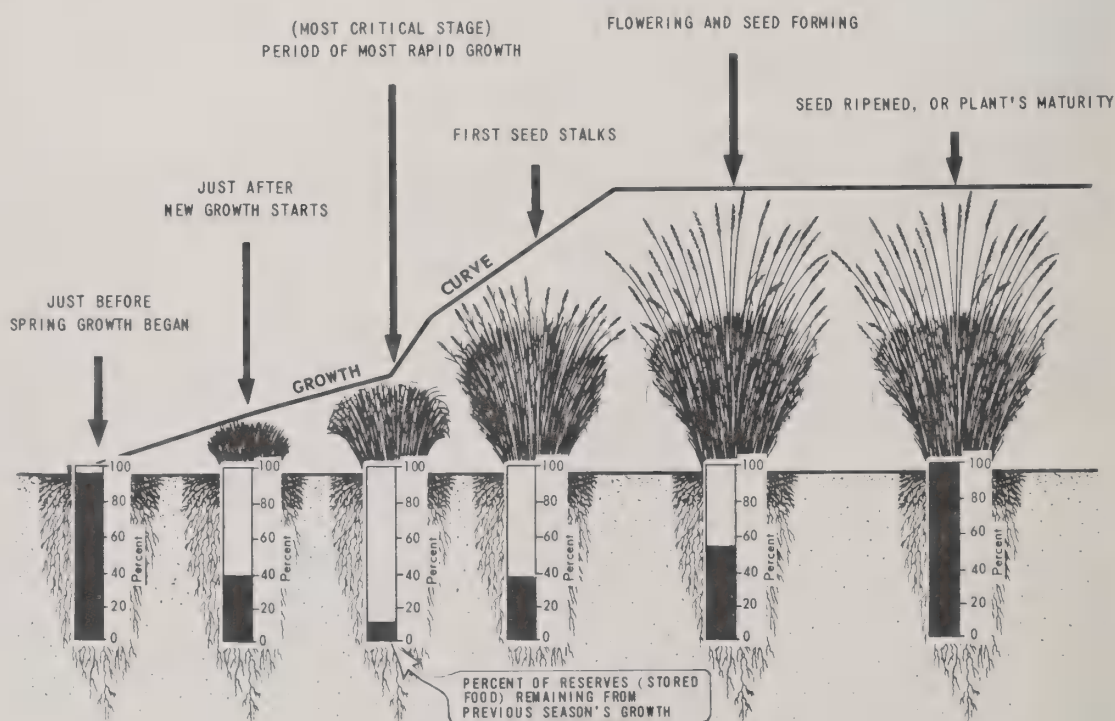
Even under the best of conditions, there may be small "sacrifice areas" around water where grazing use will be heavy, as well as under-used areas where animals do not graze enough. It is to the advantage of the livestock producer to do all he can to keep the size of both over-used and under-used areas to a practical minimum.

PLANTS NEED TO REST

In the discussion of how plants grow, it was pointed out that a part of the food manufactured in the leaves of perennial plants is stored in the roots. Normally, most of this storage is made after seeds ripen. Some of the stored food is used

during the dormant period, but most is used for making new top growth after the plant resumes growing. A plant may use three-fourths or more of its stored food to produce the first few inches of new growth. When the plant is growing very fast, the new food factory (leaves) may not supply enough food to support the plant - so still more stored food is used up. By the time the seedstalks form, the reserve food may be almost gone. (See diagram.) If plants are grazed during this rapid-growth period, they have little reserve with which to start growth again and little chance to strengthen and enlarge their root systems. They are in poor condition to compete with less palatable plants which have not been grazed and are vigorously growing.

FOOD RESERVES STORED IN ROOTS OF GRASS in relation to plant growth



Plants simply cannot stand to be grazed at this most critical time year after year. But they can be grazed at this rapid-growth stage occasionally and still remain healthy and productive.

Plants would remain most productive if they were never grazed until after seed ripening when they have already stored food for next year. On most livestock farms and ranches, of course, this would not be practical because livestock must graze throughout the year. Besides, it is during the rapid-growth period that plants are most palatable and nutritious and when they put the most gains on animals.

Nearly every livestock farm or ranch has two or more pastures. It is almost always possible to move livestock from pasture to pasture so that each pasture can be given a complete rest from grazing during some growing seasons. The oftener and longer the rest periods, the better the plants will grow. One pasture should never be too

heavily grazed in order to give another pasture a rest because of the heavy damage that may be done.

Some grassland pastures which have been badly abused in the past have only a few remaining plants of the better kinds. Such pastures particularly need growing season rest to permit these better plants to rebuild their root systems and to make seed so they can increase and crowd out the less valuable kinds of plants. Some pastures of this kind may need a rest for several growing seasons to restore their productivity.

A light rate of stocking will not help the key forage plants as much as a complete rest. Even if only a few animals are in a pasture, they still seek out the plants they like best and still do most of their grazing around water and other concentration areas. Thus, even with very light stocking during the growing season, the plants which most need a rest from grazing do not get one.

Rest during the growing season is in no way a waste of feed. Rested pastures can be grazed after the end of the rest period. A pasture which still has its full growth of plants makes a far better fall or winter pasture than one which was grazed during the growing season and has had most of the high quality plants already used up.

Growing season rest is always a "must" on newly seeded pastures. Young, tender seedlings need every opportunity for a good start so they can get ahead of weedy plants before they have to contend with grazing. Livestock particularly enjoy young, tender plants and, if permitted, will destroy them before they are well rooted and established. Some seeded pastures need to be rested two or three years before they can be grazed safely.



Newly seeded grasslands like this one in Hemphill County need protection from grazing during the growing season until the new grass plants are well established.

This Fisher County pasture was aerial sprayed to control mesquite. Then it was rested three growing seasons (grazed in the winter only). Grasses are now producing forage on water the brush formerly used.



TE 3540-8

Pastures in which brush has been controlled also need growing season rest. Actually, the main reason for brush control isn't just to kill or suppress the brush - it is to let grass grow in place of the brush. Grasses must be permitted to grow as fast as they can so they can spread out their roots and take advantage of the extra water which the brush formerly used. The grass must be able to "beat" the weedy plants to this extra water if benefit is to come from the brush control. It is an unwise investment to spend several dollars an acre for brush control then lose the benefits from such treatment because the grasses were not given a chance to take over the space cleared of brush.

Studies at the Texas Agricultural Experiment Station at Spur show remarkable increases in forage production following aerial spraying of shin oak. The brush was sprayed three times. Part of the area was rested during the growing season after each spraying. After three years, the portion which was sprayed and rested was producing 2,083 pounds per acre of plant growth while the part sprayed but not rested produced only 542 pounds per acre. Sixty-five percent of the herbage on the rested portion was classed as "good plants", while only 18 percent was from "good plants", on the sprayed but unrested area. A similar area which was neither sprayed nor rested produced only 135 pounds per acre. Growing season rest, even without chemical treatment, increased production by 715 pounds per acre.



This Motley County pasture was sprayed to control shin oak, then it was rested. Forage production has greatly increased.

TE 3918-7

Grasslands which have been burned, either accidentally or purposely, need growing season rest to permit the better plants to recover and to rebuild the litter cover on the soil surface. Livestock concentrate on recently burned grasslands because all of the grass regrowth is tender and is easy to graze. The burning itself may not permanently injure most grasses, but grazing too soon after a fire may destroy them. Rest following severe drought, insect or hail damage or very heavy grazing use is very beneficial to all kinds of grasslands.



Burned grasslands must be rested to give the good forage plants a chance to recover from the damage caused by the fire.

The right amount of use on the key plants plus frequent growing season rest will result in as rapid, or even more rapid, grass improvement than will continuous protection from grazing. Many plants are actually stimulated by light clipping or grazing and may grow better than if they were never grazed at all. Grazing after seed has ripened often helps to scatter the seed and a light trampling by animals helps to "plant" it.

GRAZING SYSTEMS

Several "systems" of grazing which combine proper grazing use with "scheduled" rest periods for each pasture are being used successfully in Texas and in several other states. More and more livestock producers are adopting grazing systems. Notable among such systems is the "Sonora" deferred-rotation grazing system developed at the Sonora Ranch Experiment Station. This system includes four pastures of about equal forage production. One pasture is rested while the other three are being grazed. Each of the four pastures, in its turn, is rested four months and then grazed 12 months. The rest periods come during a different season each year. For example, a pasture rested March through June one year will rest July through October the

second year, and again the following November through February as illustrated in the following diagram:

"SONORA" DEFERRED-ROTATION GRAZING SYSTEM

MAR - JUN		JUL - OCT		NOV - FEB		MAR - JUN	
Pasture 1 REST	Pasture 2 GRAZE	Pasture 1 GRAZE	Pasture 2 REST	Pasture 1 GRAZE	Pasture 2 GRAZE	Pasture 1 GRAZE	Pasture 2 GRAZE
Pasture 3 GRAZE	Pasture 4 GRAZE	Pasture 3 GRAZE	Pasture 4 GRAZE	Pasture 3 GRAZE	Pasture 4 REST	Pasture 3 REST	Pasture 4 GRAZE

JUL - OCT		NOV - FEB		MAR - JUN		JUL - OCT	
Pasture 1 REST	Pasture 2 GRAZE	Pasture 1 GRAZE	Pasture 2 REST	Pasture 1 GRAZE	Pasture 2 GRAZE	Pasture 1 GRAZE	Pasture 2 GRAZE
Pasture 3 GRAZE	Pasture 4 GRAZE	Pasture 3 GRAZE	Pasture 4 GRAZE	Pasture 3 GRAZE	Pasture 4 REST	Pasture 3 REST	Pasture 4 GRAZE

NOV - FEB		MAR - JUN		JUL - OCT		NOV - FEB	
Pasture 1 REST	Pasture 2 GRAZE	Pasture 1 GRAZE	Pasture 2 REST	Pasture 1 GRAZE	Pasture 2 GRAZE	Pasture 1 GRAZE	Pasture 2 GRAZE
Pasture 3 GRAZE	Pasture 4 GRAZE	Pasture 3 GRAZE	Pasture 4 GRAZE	Pasture 3 GRAZE	Pasture 4 REST	Pasture 3 REST	Pasture 4 GRAZE

Results of this system at the Sonora Station have been outstanding during the past 15 years. Forage quality has improved and production has increased 25 percent as compared with similar pastures stocked at the same rate but grazed yearlong. Besides improvement in plant cover (even during drought years), the pastures in this system have produced a higher net livestock return per acre than any other pastures on the Station, and deer numbers have increased. Results at the Throckmorton and Barnhart Stations have also shown advantages of such grazing systems over yearlong grazing use.

Other systems showing great promise are the "three-pasture" and the "two-pasture" or "South African Switchback" systems. The three-pasture system operates about like the four-pasture system except that each pasture is rested three months and then grazed six months. This moves up the rest period three months each grazing year. For example, a pasture resting June, July, and August one year will rest during March, April, and May and again in December, January, and February the second year, etc.

The two-pasture or "switchback" grazing system places all the livestock in pasture No. 1 for three months, then in pasture No. 2 for six months, back to pasture No. 1 for three months, then to pasture No. 2 for three months, and to pasture No. 1 for

six months, etc. Thus, each pasture is grazed only half the time and rested half, and the rest periods come at different times each year.

Similar grazing systems can be adapted to most ranches, often with little or no additional fencing or water developments. Such systems must be very carefully "tailored" to fit the kinds of grassland, the pastures, fencing, water, kinds of animals, and other conditions. Grazing systems are not a substitute for proper use of the key forage plants. The amount of grazing use is just as important as on grasslands grazed yearlong. The main benefit from such systems comes from carrying out the regularly scheduled rest periods each pasture receives.

BALANCING LIVESTOCK AND FORAGE

Most livestock producers wish to keep income from livestock as high as possible each year and, at the same time, to increase the amount and quality of forage being produced year after year. To meet both these goals it is necessary to carefully determine how many animals can be properly fed on the forage produced without overusing the key plants.

It has been more or less traditional in many parts of the state to stock grasslands on the basis of so many animals per section or so many acres per animal. Unfortunately, not all grasslands in any location produce the same amount and quality of forage - nor does any pasture produce the same amount of forage every year. Therefore, each pasture should be stocked on the basis of its actual forage production.

The feedlot operator decides how many animals he can profitably feed only after he determines how much roughage and concentrates are available. If his feed supply is low, he does not try to feed a large number of animals, regardless of how much yard space he has. Likewise, on grasslands, the most successful livestock operator stocks on the basis of the amount of forage available rather than on the acres within his ranch or farm.



The number of animals fed in this feedlot depends upon the amount of concentrate and roughage available. Grasslands also should be stocked on the basis of available forage.

There are several ways to determine whether the number of livestock in a pasture is in balance with the amount of usable forage. Perhaps the best way is to watch what is happening to the key plants (the kind the operator wants to increase on his lands) under the present rate of stocking. The livestock operator can easily tell how well these plants are growing by looking for "indicators" such as: Are the key plants healthy and vigorous? Are they making as good growth as could be expected with the present moisture conditions? Are they producing many seedstalks? Are the leaves long and the roots healthy and strong? Are there seedlings and young plants of the key kinds? Are the key plants moving out into bare spots? Is the amount of litter building up so it can protect the soil and help to hold moisture? If the answer to these questions is "yes," the pasture is not being too heavily used.

Properly used pasture. About half of the "key plant", little bluestem, has been left. Plants are vigorous and thrifty. They will make good growth again next year and the soil is well covered with mulch.



TEX 44,369-A



This pasture has been too heavily grazed. Only about 20 percent of the "key plant", black grama has been left. Plants are spindly and weak. They may not survive a drought. Much of the soil surface is bare and will not soak up rainfall very fast.

The condition of livestock is often used as an indicator of what is happening to the forage plants. This is all right up to a point. But livestock can look good for some time after forage starts to give out and key plants begin to weaken.

If the key plants are being used too heavily (50 percent removal of top growth is proper use) with the present number of animals, then there are too many animals in the pasture. The operator should not wait until the end of the grazing season to make such determination because it is then too late to make any needed adjustments in stocking rate. For example, if a pasture is to be grazed yearlong and the livestock have taken more than 25 percent of the growth of the key plants during the first six months of the grazing season, the stocking rate is too high for that year and it must

be reduced or these plants will be too heavily used by the end of the grazing season. On the other hand, if forage is abundant and there has been light use on the key plants, the stocking rate can be increased for the remainder of the grazing season.

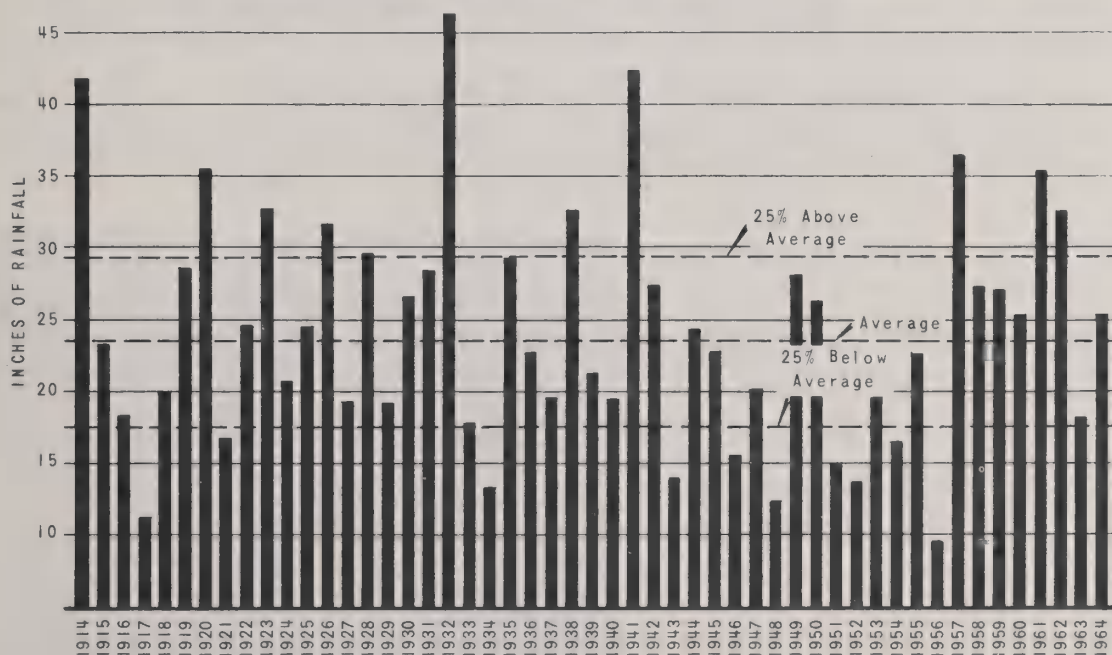
Other things which affect stocking rates are the kinds of grazing animals and the kinds of plants they prefer, the season of grazing use, distribution of livestock water, and the uniformity of grazing use within the pasture.

The stocking rate is one of the most important decisions the livestock operator must make - both for the present and the future. By heavy grazing it may be possible to get higher livestock returns for a short time. However, too heavy grazing will damage the forage plants and will result in a much lower stocking rate in the future. Livestock returns in any one year should not reduce chances for similar or greater returns in following years.

FLUCTUATING FORAGE PRODUCTION

A glance at the 51-year record of rainfall at Abilene, Texas, confirms what every grassland manager knows so well - we don't get the same amount of rain every year. This record, typical of almost any place in Texas, shows that rainfall was average or above during 26 years and was below average during 25 years. For these reasons, therefore, we should not expect forage production to be the same every year. Besides, forage production does not vary directly with the total amount of rain in any one year. The timeliness and distribution of the rainfall is just as important to forage production as the total amount that falls. Most of the above-average years at Abilene had one or more torrential storms with several inches of rain falling within a very short time. Much of the water from such storms does not get into the soil to grow forage. Summer showers of one-half inch or less add to the total for the year but seldom contribute to forage growth because of shallow penetration. A good

51-YEAR RECORD OF RAINFALL AT ABILENE, TEXAS



example of the importance of distribution of rainfall occurred in 1964. The total rainfall for that year was above average for Abilene, but several inches of it came late in the fall after the end of the growing season. Forage production for the year was much below average.

Differences in amount and distribution of rainfall are reflected in forage production. For example, during the six years from 1958 to 1963, production from an excellent grassland area near Austin averaged 6,495 pounds per acre. But in 1962 it was 8,200 pounds and in 1963 it was only 3,900 pounds - a difference of over 4,000 pounds per acre

In drought years, forage production on some sites may be only one-third as much as in good years, and there is a tendency for drought years to come in "bunches."

If grassland pastures are stocked on the basis of production expected in good years - or even in "average" years, they will be severely damaged during dry years. Damage from too-heavy use during a dry year may not be completely corrected by proper grazing during several good years. Droughts have always been with us and we can expect them in the future. Grasslands suffer most from misuse during drought - they are less often hurt in wet years.

Balancing animals with forage production is always important and especially so during dry years. It is also important that the livestock producer be able to take advantage of the extra forage which grows during favorable years.

STOCKING RATES CAN BE FLEXIBLE

Variability in forage production from year to year presents two main problems to the livestock producer: (1) How to make adjustments in numbers rapidly enough to prevent overuse of forage plants when production is low, and (2) How to keep income as high as possible when the source of income - the forage crop - is so variable.

Sooner or later during serious droughts every livestock operator makes some adjustments in livestock numbers on his grasslands. Too often, however, these adjustments are made too late to avoid animal weight losses, injury to forage plants, and costly feed bills. There is always the temptation to gamble on that "one more good rain" that will pull us through a drought. But the gambling odds are seldom in our favor and we usually hurt our forage plants while we wait for that rain to come.

Much time and money
is invested
in building a fine breeding herd
and it is hard
to sell such
good animals when
drought comes.



Many livestock producers have spent years building up their breeding herds with high-priced breeding stock and selective culling. When drought comes, such operators are understandably reluctant to dispose of such animals in which so much money, time, and care have been invested. There is a common saying that "you can't sell a cow because she has either just had a calf or is about to have a calf." When a livestock herd is made up entirely of breeding animals, it is always difficult to make adjustments in numbers when forage supplies are so erratic.

One alternative is to stock at a rate low enough that there will be plenty of forage in all except prolonged drought periods. This is seldom efficient, however, because much good forage is unused during years when production is high. A more economical system is to make up a herd with 50 to 65 percent breeding animals and the remainder of stocker type animals such as yearling cattle, wethers, or muttons. Then, when forage growth is poor, the stockers can be marketed early and a good reduction in numbers can be made without cutting into the basic breeding herd.



PHOTO COURTESY TEXAS AGR. EXT. SER.

When part of the herd is steers or other kinds of stockers, they can be quickly marketed when forage supplies are short.

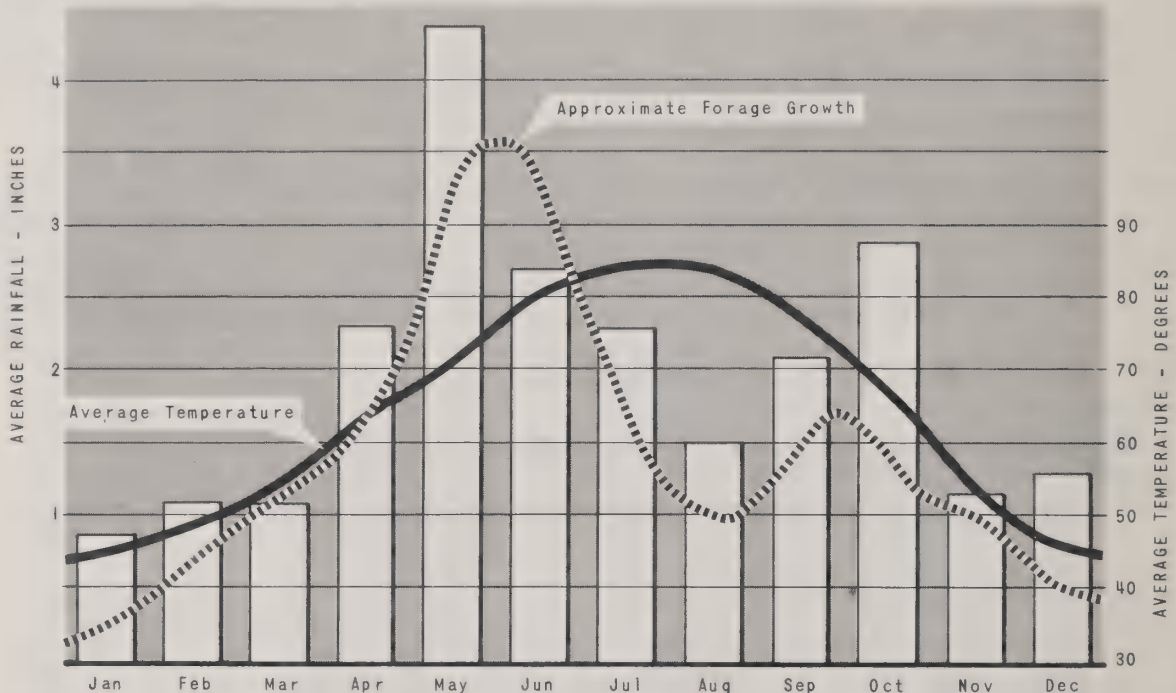
With such a herd the operator can hold over more calves, lambs, or kids or purchase additional stockers when forage production is high. This flexible method of stocking, if properly geared to forage growth, will permit the most economical use of forage and still allow for grassland improvement.

An even more flexible stocking system used by some operators is with a herd made up entirely of stocker type animals. Under this system, the animals are not purchased until near the end of the growing season when the forage is "on the ground" and the number of animals purchased is in proportion to the available forage supply. The stockers are then marketed at the beginning of the next growing season or as soon as the key plants have been properly used.

Even with a flexible herd, it is important that the livestock producer recognize as early as possible when adjustments in numbers will be necessary.

The chart showing average monthly rainfall for Abilene also shows average temperatures and the approximate average seasonal growth of forage plants. It can be readily seen that the highest rate of plant growth normally comes during May and

AVERAGE MONTHLY RAINFALL, TEMPERATURE, AND APPROXIMATE RATE OF FORAGE GROWTH
ABILENE, TEXAS



June. Growth then slows down during July and August and normally reaches another "peak" in late September. (Although the main growing periods are slightly different for other parts of Texas, they follow about the same pattern as at Abilene.)

This chart indicates that most grassland forage is usually produced by early July with some additional growth in September if rains are favorable. Unfortunately, neither of these main growing periods is entirely dependable. Therefore, if forage growth by July is much below average, the odds are heavily against making up for this shortage of forage during the September growth period. In other words, if production by July is very low, the operator will almost always be short of forage before the end of the grazing season - unless he makes prompt adjustments in numbers of animals. Likewise, if forage growth is very good by July, the operator can expect at least a little more growth in September and may be able to safely increase his stocking rate for the remainder of the grazing season.

Thus, if the operator sees that forage growth by July is poor, he should immediately begin to market his surplus animals and cut his herd down to the number for which he has feed. By doing this, he will be saving the feed that these marketed animals would have used between July and the usual marketing date later in the fall. This saved feed will then be available for the breeding herd which must be kept through the following winter. Early weaning and marketing of calves or lambs during dry years helps keep their mothers in good condition to breed again. This increases chances for a satisfactory calf or lamb crop the following year.

When the operator waits until he is short of feed before making adjustments, he most often finds the market unfavorable, animals in poorer condition, feed costs higher, and, most important, his forage plants damaged.

GOOD GRASSLAND MANAGEMENT PAYS

Livestock producers make money by selling grass in the form of animal products. Although it might seem that the more livestock we have, the more profit we make, this is not necessarily true unless there is ample feed for all the animals throughout the year. Profit depends on income minus the expense of producing that income. The greatest net return in the long run comes from grasslands on which animal numbers are in balance with the amount, kind, and quality of available forage.

While it is often true that more pounds of livestock products per acre can be produced temporarily by heavily grazing the forage, the production per animal and the net return is almost always lower than under conditions of proper grazing use. Besides, such heavy grazing reduces the future production and prevents the improvement of grasslands.

Well-fed livestock, like well-fed plants, are the best producers. When plenty of forage is available, animals normally prefer the more tender growth of plants - the parts which are most nutritious and most easily digested. Under heavy use, however, animals are forced to eat more of the coarser and less nutritious plant parts and their diet contains a smaller percentage of the better nutrients. Also, the digestibility of this coarser material is reduced. In addition to reduced nutrients and reduced digestibility, animals actually eat less feed per day from heavily grazed plants than from properly used plants so are less able to make profitable gains.

Actual records from operating ranches in Texas clearly show that net returns from proper use outweigh those from too heavy grazing. For example, the following records from the John L. Basket Ranch in Mason County - a 1,324 acre ranch in an area which has an average annual rainfall of 25 inches:

PRODUCTION RECORDS ON THE JOHN L. BASKET RANCH

Year	Annual Rainfall	Number of Cows	Acres per Cow	Number Dry Cows	Percent Calf Crop	Average Calf Weight	Pounds Calf Per Acre	Total Calf Weight
1st	22"	103	13	28	72.8	375	21	28,125
2nd	34"	85	15	15	82.4	500	26	35,000
3rd	20"	60	22	5	91.7	600	25	33,000
4th	13"	60	22	0	100.0	600	27	36,000
5th	28"	60	22	1	98.3	550	24	32,450
6th	17"	62	21	0	100.0	585	27	36,270
7th	11"	64	20	0	100.0	550	26	35,200
8th	21"	62	21	1	98.4	580	26	35,380

As can be seen from the above record, there was an increase in the total weight of calves for market when the breeding herd was reduced from 103 cows to 60 cows. This increase resulted from a higher calf-crop percentage and heavier calf weights under a stocking rate which permitted the proper use of the forage plants. These gains were made despite below average rainfall during five of the six years after reduction in cow numbers. Net returns from livestock were also higher because of the reduced

Well-fed
livestock are the
best producers.



TE 2792-7

expense of maintaining fewer animals and the almost complete elimination of costly supplemental feed.

As compared with too-heavy use, the proper use of grassland plants results in:

- | | |
|-------------------------------------------------|-------------------------------------|
| 1. Higher gains per head of livestock | 8. Lower investment in livestock. |
| 2. More wool and mohair per animal | 9. Fewer poison plant problems |
| 3. Higher calf and lamb crop percentages | 10. Less labor and equipment needed |
| 4. Higher calf and lamb weaning weights | 11. Reduced effects from drought |
| 5. Better livestock condition at marketing time | 12. Lower feed costs |
| 6. Fewer nutritional problems | 13. A better home for wildlife |
| 7. Lower veterinary costs | 14. A more stable livestock economy |

These benefits, along with improvement in yield and quality of forage on well managed and properly stocked grasslands far outweigh any temporary gains from too-heavy grassland use.

SUMMARY

The goal of good grassland management is to restore or maintain production of the maximum amount of high quality forage each acre is capable of growing, to make efficient use of that forage, and to maintain high animal production through the years.

The right amount of use of key plants each year along with well planned rest periods for those plants is the most effective, yet least expensive way to improve grasslands. A few good rules to follow in the management of any grassland are:

1. Use half and leave half of the forage from the key plants.
2. Fit the kinds of livestock and wildlife to the kinds of forage.
3. Keep numbers of animals in balance with the forage supply.
4. Keep stocking rates and herd composition flexible so numbers of animals can be quickly adjusted to year to year and season to season changes in forage production.
5. Plan frequent rest periods of adequate length during the growing season.
6. Watch what is happening to the key plants.

and, where needed:

1. Control undesirable woody plants and keep them under control.
2. Re-establish desirable plants where there are too few left to come back quickly enough through good management alone.

No two grasslands are exactly alike, so no two grassland management plans should be exactly alike. Each plan should be carefully tailored to the needs of the plants, soils, water, livestock, and wildlife of the grassland and to the desires of the operator.

In each soil and water conservation district in Texas, Soil Conservation Service technicians are available to help landowners evaluate their grassland resources and to help them develop and carry out the kind of management plan best suited to their lands and to their objectives. The grassland operator can use the technical knowledge of such technicians, along with his own knowledge and experience, in planning for the best use of his grasslands for the long run.



TE 368-7

With assistance of Soil Conservation Service technician, this grassland operator studies the kinds and amount of forage available. This is a step in the development of his grassland management plan.

We must always remember that the half we leave to feed the plant is not wasted forage. It is an investment in future forage production. It is a way to "get bigger within our own fences." The man whose pasture looks only half used gets more grazing and makes more net profit than the man whose pasture is kept short. To the livestock operator, good grassland management is the key to staying in business. Even with high land prices and increasing costs, high quality grass is still the cheapest livestock feed we can grow.



The man whose pasture looks only half used gets more grazing and makes more net profit than the man whose pasture is kept short.



TE 291-2

Good grassland management + good animals = profit and pride of ownership.

Grassland management is a game that must be played according to the rules - and Mother Nature wrote the rule book

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GRASSLAND RESTORATION

Part V

Effect on Water Yield and Supply



Tex-47-157

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION, SERVICE, TEMPLE TEXAS

June 1967

Water has always been the least abundant resource, particularly in the western part of the state. As population and industries grow, it will become even more valuable.

Many organizations are studying and developing plans for conserving water resources, usually involving immense and costly projects. Often overlooked as an important possible source of saving water is the water wasted by non-economic plants, weeds and woody invaders. These silent thieves are stealing more water in Texas every year than is consumed by all the towns, all the factories, and all the agricultural plants - crops, orchards, grasses and commercial timber trees.

It will shock most Texans to learn that scientists estimate about one hundred thirty-eight million acre-feet of water - almost 38 percent of the average annual precipitation - are consumed by non-economic plants.

The brush survey made by the Soil Conservation Service in 1964 found that eighty-eight million acres, 82 percent, of Texas' grasslands were infested with brush, fifty-four million acres so dense that most of the moisture that entered the soil was consumed by the brush.

Grass is a more efficient user of water than most woody plants, requiring less water to produce a pound of dry matter. There is less water used on an acre of grass than on an acre covered with woody plants or weeds. A grassland restoration program, involving the control of undesirable plants and replacing them with grass, would result in a saving of water, most of which would be available for deep percolation into underground aquifers and as return flow to streams.

Just how much could be saved is somewhat difficult to estimate since there is so little research available from Texas on moisture consumption by non-economic plants. Using all available information including research data and studies and experiences of Soil Conservation Service Hydrologists, Engineers, and Soil and Plant Scientists, it is estimated that about ten million acre-feet of water could be saved annually by brush control as part of a statewide grassland improvement program. Others may not agree with this estimate but all must recognize that such a program will save large quantities of needed water.

Landowners are presently treating about two million acres of brush annually, often with financial assistance through the Agricultural Conservation Program or the Great Plains Conservation Program. However, this amount is hardly keeping up with the rapid increase in density of brush on Texas grasslands and the reinfestation within a few years of acres treated.

The importance of water conservation is so widespread that a concerted effort and the support of all interests are needed to accomplish the job. Grassland restoration as a means of saving water is apparently one of the cheapest means of saving water, less costly than but not a substitute for de-salinization of sea water or transportation of water for hundreds of miles to thirsty lands. A grassland restoration program would not only save water, but the improved grass cover would provide more grass for a more stable livestock industry. Increased wildlife, recreation, and beautification purposes would be important additional benefits. Every Texan will benefit from such a program.

H. N. Smith

H. N. Smith, State Conservationist
Soil Conservation Service, Texas

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GRASSLAND RESTORATION

PART V

EFFECT ON WATER YIELD AND SUPPLY

By
C. A. Rechenthin, Soil Conservationist
and
H. N. Smith, State Conservationist

USDA, Soil Conservation Service,
Temple, Texas

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CATALOGING - PREP

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GRASSLAND RESTORATION

PART V

EFFECT ON WATER YIELDS AND SUPPLY

By

C. A. Rechenthin, Soil Conservationist,
and

H. N. Smith, State Conservationist

USDA, Soil Conservation Service
Temple, Texas

THE PROBLEM

Insidious thieves steal more water every year in Texas than is used by all the towns, all the factories, all the farms, and all the people. They annually use almost five times as much water as is stored in all the reservoirs in the state.

These thieves are the weedy and woody invaders, most of them having little or no value, that are infesting the grasslands of the state.

About ten million acre-feet of water could be saved annually by controlling a major portion of these water thieves, the undesirable brush which is one of Texas' biggest range problems. This is more water than is presently being used annually by industrial and municipal purposes. It is about one-third as much water as will be stored in proposed dams of the Texas Water Plan at a cost of 1.75 billion dollars. (1). The water saved could contribute appreciably to alleviating future water shortages.

(1) THE TEXAS WATER PLAN – Texas Water Development Board, 1966



Te 5447-12

Mesquite, one of the water thieves has the ability to sap the moisture from a large area, as it has done in this cotton field.

The late Dr. Walter Prescott Webb, an authority on Texana, wrote in HARPER'S MAGAZINE, December, 1953, that stream runoff was the only water that could be saved and used in a land that needs water more than anything else. Dr. Webb overlooked, as have many others, the greatest single cause of water waste in the state - the host of worthless, water-robbing weeds and woody shrubs and trees that have infested most of the grasslands of the state.



Te 821-9

Thickets of brush like this use all the rainfall that occurs. Very little useful forage is produced.

Scientists have estimated what becomes of the precipitation in the state. The data in Table 1 was developed by Dr. J. R. Johnston of the Agricultural Research Service of the U. S. Department of Agriculture.

Table 1 - Average Annual Water Budget for Texas (2)

	Acre-feet	Percent
Income - Rain, snow, sleet	366,600,000	100.0
Outgo		
Runoff	52,446,000	14.2
Industrial, municipal, and irrigation consumption	7,500,000	2.0
Surface evaporation	3,000,000	0.3
Discharge into sea	41,946,000	11.4
Evaporation	145,000,000	39.6
From plant cover	45,000,000	12.3
From soil surface	100,000,000	27.3
Transpiration	168,154,000	45.9
From non-economic plants	138,154,000	37.7
Cultivated crops	11,000,000	3.0
Range and pasture plants	11,000,000	3.0
Commercial timber trees	8,000,000	2.2
Ground water storage	1,000,000	0.3

This table shows that non-economic plants use 10.1 inches of the average annual precipitation of 27 inches. Another 7.6 inches is lost by evaporation from the soil surface. A total of 17.7 inches is lost to nonproductive uses.

It is in these two losses that great opportunity exists to save water. A grassland restoration program would not only reduce the consumption of water by worthless brush, but would also reduce surface evaporation losses by restoring and maintaining a good grass cover. This would make more water available for deep percolation into underground aquifers, and as return flow to streams.

Other estimates vary somewhat from those of Dr. Johnston. The Texas Water Commission estimated that municipal, industrial, and irrigation uses in 1961 were 29,082,900 acre-feet. (3) Of this, 18,203,700 acre-feet came from surface supplies, and 10,879,200 from underground sources. However, 14,343,000 acre-feet were return flow to streams, representing a net loss from surface supplies of less than 4,000,000 acre-feet.

(2) J. R. Johnston - "The Significance of ■ Water Budget for Texas",
PROC. THIRD ANNUAL WATER FOR TEXAS CONFERENCE, Texas A & M U., 1957

(3) THE TEXAS ALMANAC, 1964-1965, The Dallas Morning News.

The Texas Water Commission found in making an inventory of irrigation that irrigation use of surface water in 1958 was 2,502,610 acre-feet, and 2,219,079 in 1964. Ground water use for irrigation was 10,290,573 acre-feet in 1964. (4). These data indicate that recharge to ground water storage must be somewhat higher than the one million acre-feet estimated by Dr. Johnston. However, it is known that Water tables in most of the major aquifers of the state are declining, so recharge does not equal consumption.

Dr. Johnston's estimates do serve to point up the seriousness of the problem of water loss in Texas through non-economic plants.

Every Texan is affected by this insidious waste of water. Water used by saltcedar, mesquite, lotebush, and shin oak on the upper reaches of the Brazos and Colorado Rivers is water lost to the cities and irrigators downstream. Water consumed by oaks and associated species on the upper Trinity never reaches the reservoirs supplying Fort Worth, Dallas, and other cities. Water transpired by saltcedar on the Rio Grande and Pecos Rivers does nothing for the thirsty citizens and lands of the Lower Rio Grande Valley.

Water is one of the state's most valuable resources today, probably more valuable than cattle, oil, or cotton. In 1951, George D. Clyde, noted authority on irrigation in the Western States, estimated that an acre-foot of water was worth from \$6 to \$60 for irrigation purposes, depending on supply, cost of storage, diversion or pumping. (5). At the estimated value of \$50 per acre-foot, which should be conservative because of increased costs and demands, an annual saving of only one inch of water on each acre of Texas grasslands infested with brush through a grassland restoration program would result in saving almost \$370,000,000 worth of water for other uses each year.

The possible saving of ten million acre-feet of water is a conservative estimate, and represents a saving of about one and one-third inches per acre infested with brush. The cost of ten million acre-feet of water, if it had to be obtained by desalinization of sea water at 28 cents per thousand gallons, would be almost a billion dollars annually. The cost of saving water by a grassland restoration program would be largely offset by the benefits from increased forage production, thus making the water saving almost a "bonus."

A grassland restoration program, including brush control, revegetation, and grassland management, would be a long step towards assuring the people of Texas increased water supplies for a long time to come. Such a program would of necessity take into consideration and assure optimum benefits for all purposes, including wildlife, recreation, and beautification, as well as grassland and watershed uses.

The Soil Conservation Service has issued a series of publications on GRASSLAND RESTORATION. The first of the series discusses "The Texas Brush Problem" as found in a 1963-64 survey. Part II presents the various methods of "Brush Control." Part III

(4) INVENTORY OF TEXAS IRRIGATION, 1958 and 1964; Texas Water Comm., Bul. 6515

(5) George D. Clyde - JOUR OF SOIL AND WATER CONSERVATION; Vol. 6, No. 2, 1951

issued in 1965, gives guidance on "Re-establishing Forage Plants". Part IV, 1966, tells the important principles of "Grassland Management" without which the program is not complete and cannot be successful.

CONSERVATION ON GRASSLANDS WILL SAVE WATER

There are numerous examples in the state which show that saving water through conservation treatment is no idle dream.

One of the most striking examples can be seen on the Flat Top Ranch near Walnut Springs. The late Charles Pettit developed a ranch by purchasing a number of smaller units which had been cropped and grazed until the fields were eroded and badly "worn-out". Many abandoned fields were covered with worthless brush and weeds. The grasslands were almost bare of grass, and some were infested with dense brush - mesquite, sumac, juniper, and others. The main watercourse through the ranch was a dry gravel bed that quickly developed into a roaring, angry torrent of muddy water during heavy rains. The stream dried up almost as quickly again when it stopped raining. Most of the rainfall either ran off or was consumed by weeds and brush.

Pettit developed a conservation plan for the ranch with the assistance of the Soil Conservation Service. It included reseeding old fields to grass, terracing and other needed practices on the remaining cropland, clearing the ranges of undersirable woody plants, leaving mottes and large trees for wildlife cover and shade, construction of ponds to store water, and grazing management to restore the grasses on the rangelands.

The results amazed Pettit and the Soil Conservation Service men helping him. As the grasses were restored and the ponds filled with water, long-dry and forgotten springs began to flow again. The usually dry creek bed which entered the Flat Top Ranch at one end became a beautiful clear running brook as it progressed through the ranch. Floods now occur only during major storms, and the ponds remain clear, instead of filling with silt-polluted water.

Another outstanding example is in West Texas where average rainfall is less, and water is perhaps more valuable. George Skeete, ranching near Water Valley northwest of San Angelo, knows what watershed treatment can do.

Skeete realized during the drought-stricken days of the 1950's that conditions on his ranch were serious. As far as his eye could reach, there was an endless stand of brush. There wasn't enough grass to keep his livestock and ranch going. With the help of a long-range conservation plan, Skeete began a vigorous campaign to restore his grasslands. He rootplowed or dozed cedar, mesquite and other brush and reseeded to hasten recovery. He rested all newly treated areas until the grass was well established and practiced conservative grazing to permit grasses to make maximum recovery. Under his system of management, the grasses improved and soon covered his rangeland, replacing the former thickets of brush. Skeete noticed with surprise that a dry spring, almost forgotten but once the center of a large ranching spread, began to flow again. The grass cover and the

holes where the brush was dozed out acted as sponges to absorb the rains, and the grass cover reduced evaporation losses. Removal of the deep-rooted water-robbing brush permitted some of the water to percolate downward into the aquifers that fed the spring. Except for the two-year drought of 1963-64 in the area, the spring has continued to flow.



The 2792-9 Watersheds with conservation treatment applied have a good cover of vegetation of many kinds, which provide watershed protection, efficient utilization of rainfall, and an abundance of forage and food for livestock and wildlife. Waste of water by evaporation and loss to worthless brush is minimized.

In the following pages, detailed information will be given regarding water use by brush, and what could be expected in water savings from a statewide comprehensive grassland restoration program.

GRASS HAS BEEN REPLACED BY WEEDS AND BRUSH



Tex 40,579 - When Texas was first settled by white men, it was noted for its rich grass resources. The original cover must have looked much like this. The thick grass provided good soil protection, absorbed the rainfall, and resisted the invasion of weeds and brush.

Heavy grazing, associated with drought and uncontrolled fires, removed the original grass turf, and either killed or seriously decreased the good forage species. Range scientists estimate that at least 80 percent of the state's rangelands have been so depleted that no more than one-half of the good forage plants still remain. These are the rangelands that are most susceptible to encroachment by weeds and woody plants.

The pictures on the next page tell the tragic story of denuded rangelands. Study them closely.



Te 771-11

This bare range near San Angelo was wet only ten inches deep by a hard 5.5 inch rain. No more than 2 inches of the rain was absorbed, and much of that was soon lost by evaporation. Only quick-growing desert-type plants can grow in this environment. Two weeks later this range was again suffering from drought.

Te 771-10 - More than 3.5 inches of the badly needed rainfall ran off, carrying with it valuable soil, washing out fences, and creating a damaging flood. This devastating scene was only a short distance from the site of the first photo. Ranges with a good cover would have absorbed most of the rain and would have produced 1,500 to 2,000 pounds of forage.



Ranchers can't afford the loss of their soil and water resources. Bare ranges not only let valuable water run off, but are susceptible to invasion of weeds and other undesirable plants, and waste water through needless surface evaporation.



Te 143-11 - Annual weeds germinate and mature seed quickly and are usually first to move into denuded ranges. Those not grazed are able to spread and soon take over the range. Buffalobur and hairy caltrop are the most abundant plants here, and with cactus, are using the soil moisture. Both weeds are worthless for forage and caltrop is poisonous.



Tex 49-167 - Bitterweed, a poisonous weed of the Edwards Plateau, occupies most of this range. It not only is using water badly needed for grass production, but also endangers the sheep industry in the region.

Woody plants move into depleted rangelands more slowly than weeds, but just as surely.

Te 5936-11 -

A multitude of young plants are turning this once grassy plain into a mesquite thicket.

Originally there were only a few scattered trees.



Birds and wild animals as well as livestock carry seed from brush-infested areas. Seed of many species, such as mesquite and juniper, germinate more readily after passing through the animal's digestive system than does seed that falls directly on the ground. Seed that germinate on denuded ranges are better able to send down roots and get established than seed that germinate on grass-covered soil.

The invasion and thickening of the brush on the grasslands of the state has become one of the major problems of grassland agriculture. Though authorities do not always agree on how much brush was in the original composition, all agree that it certainly has thickened and has spread to many acres once open prairie. A survey made by the Soil Conservation Service in 1963-64 showed that 88.5 million acres, 82 percent, of Texas grasslands are now infested with one or more species of worthless or low-value brush. (6)

Te 299-7 - Fifty

four million acres, 50 percent, are so densely infested with brush that livestock have difficulty in finding enough forage to survive.

Rainfall is being wasted to produce almost useless material.



(6) H. N. Smith and C. A. Rechenthin - GRASSLAND RESTORATION - THE TEXAS BRUSH PROBLEM, USDA-SCS, Temple, Texas June, 1964

WEEDS AND BRUSH ARE WATER THIEVES

There is no question but that a large amount of the state's water resources are being used in the production of worthless plants, or plants of low value.

Weeds are wasteful users of water. The following information compares water consumption by some common rangeland weeds with consumption by grass, expressed as pounds of water to produce a pound of dry matter:

Table 2 - Comparison of Water Consumption by Weeds and Grass (7)

Name of Weed	Pounds of Water	Name of Grass	Pounds of Water
Cocklebur	432	Buffalograss	308
Gumweed	537	Mixture buffalograss	
Sunflower	683	and blue grama	389
Lambsquarter	801		
Western ragweed	948		

Most of the woody plants are also extravagant users of water. Renner and Love have this to say:

"Those plants produce little or no forage and use water inefficiently. Many of the shrubs require 2 to 4 times more water to produce a pound of dry matter than do the perennial grasses. The amount of water needed to produce 740 pounds of dry matter for mesquite, 600 pounds of burroweed, or 1,200 pounds of fringed sagebrush, for example, would produce a ton of blue grama. Moreover, once some of the shrubs become established in normal grassland, they have the effect of increasing the aridity of the area because they provide little protection against runoff and make it almost impossible for the grass to become established naturally. If the stands of these woody plants can be reduced, great quantities of water could be made available for a better use." (8)

Research in Texas on water consumption by weeds and woody plants is very limited. Haas and Leinweber found that on a typical warm summer day, a young mesquite plant may pump more than its own weight in water and expend it into the atmosphere as vapor. (9) Hoffman reported that a mesquite stand that has a canopy shading 50 percent of the soil can use up to 9 acre inches of water per month during the growing season. (10)

Other research from the southwestern states and other sources will be cited in estimating water savings by control programs.

(7) L. J. Briggs and H. L. Shantz - JOUR OF AGRIC RESEARCH, Vol. 3, No. 1, 1914

(8) F. G. Renner and L. D. Love - WATER, 1955 YEARBOOK OF AGRICULTURE.

(9) R. H. Haas and C. L. Leinweber - AMERICAN BREEDS, July 1966.

(10) Garlyn O. Hoffman - DOWN TO EARTH, Vol. 22, No. 4, Spring 1967



Te 5448-8 - Oaks on this Cross Timbers soil are sapping the moisture from a 30-row strip at the edge of this peanut field. This shows the large area from which the trees draw their moisture. There is almost no forage produced in the thickets, and the rainfall is being wasted.



Tex 47,527 - A look under the surface of a brush-infested range will show why brush can sap the moisture from the soil. Mesquite (left) and granjeno (right) roots almost fill the soil. Note that the brush gives little protection from erosion.



Te 6701-6 - The woody plants not only fill the surface soil, but also have deeply penetrating roots as seen here in a ten-foot deep cut. Mesquite roots have been found in a mine as deep as 125 feet. The deeply penetrating roots intercept moisture that would normally percolate downward to recharge the underground reservoirs, or may even draw water directly from the aquifer.

Water consumption by phreatophytes - moisture-loving plants growing adjacent to streams, lakes and ponds, and on soils with high water tables - is extremely heavy and a big loss in Texas, and steadily mounting.

Fletcher and Elmendorf say this about phreatophytes:

"Men who have studied the problem throughout the West realize that a large part of the water consumed by phreatophytes could be put to beneficial use by replacing the phreatophytes with crops, grass, or other beneficial use. -- Many persons believe that the high consumption of limited water supplies by phreatophytes is one of the serious problems facing the irrigated West. -- From studies made by the Department of Agriculture in 1940, the National Resources Planning Board concluded that average consumption of water in the Pecos River delta above McMillan Reservoir, occupied by a dense growth of saltcedars, was about 5.0 acre-feet annually, derived from ground water, surface water, and precipitation." (11)

Common phreatophytes in Texas are saltcedar, willow, baccharis, and cottonwood. Saltcedar is rapidly spreading, and now occupies about 600,000 acres on the major streams and lakes of West and Northwest Texas.

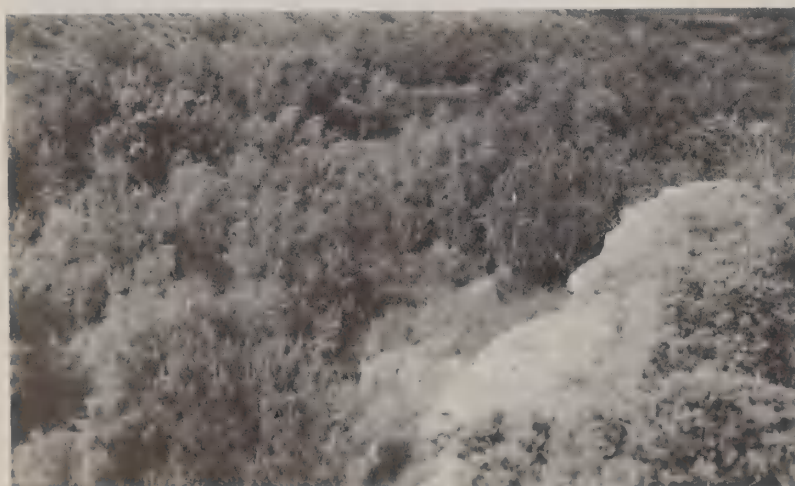
(11) H. C. Fletcher and H. B. Elmendorf - "Phreatophytes - A Serious Problem in the West" - WATER, YEARBOOK OF AGRICULTURE, USDA, 1955



Te 7266-6 - Saltcedar forms a dense stand on the Prairie Dog Town Fork of the Red River. It is beginning to get established on sand bars and choking the stream.



Te 5573-2 - Saltcedar rings Imperial Reservoir near Grandfalls. This phreatophyte consumes a large amount of water from reservoirs.



Te 7154-16 - This livestock pond is almost covered by saltcedar. Investigators have found saltcedar will withdraw as much as 5 to 7 acre-feet of water when the roots draw directly from ponds or water tables. (12)



Te234-9

DYING SPRINGS AND STREAMS

The above dam on the North Concho River, seen from the downstream side, is a symbol of a stricken land. The dam stands empty, almost filled with sediment, the pumps silent. Bass seldom leap up the fishwalk because the stream rarely flows, only for short periods during flash floods. The dam and pumps used to supply water for Sanatorium, Texas.

People like to blame the failure of the stream on "the drought". "It doesn't rain any more like it used to."

In the background of the picture, and all over the watershed, can be seen the principal cause of the death of the river - the thick growth of mesquite, catclaw, lotebush, and other brush that is taking a tremendous toll of the water resources of the area.

Reservoirs can't store water that never reaches them.

The North Concho River story is happening all over the state to some degree. It is worthy of a real good look.

Three centuries ago the first Spanish explorers on the Concho were delighted at the abundance of water, fish, and game, and proclaimed this to be the richest region in all New Spain.

One hundred years ago when the Texans began to settle in the region, it hadn't changed much. The North Concho River was a running stream, fed by numerous springs and lined by pecan groves. Waterman Ormsby, reporter for the NEW YORK HERALD, crossed the river on the first west bound trip of the Butterfield Overland Mail in 1848. He described the river as a flowing stream of considerable size. A concrete culvert had to be constructed for the stage crossing. Ormsby also described Grape Creek, a major tributary of the North Concho, as a flowing stream full of fish and the channel lined with grapevine-covered trees.

John A. March, who ranches on the headwaters of Grape Creek, told Soil Conservation Service employees that in the early 1900's, Grape Creek was fed mostly by three permanent springs. Each of them flowed into deep pools of clear water which were favorite fishing and swimming holes for the ranch residents.

The late J. R. Mims of Water Valley worked on Grape Creek and North Concho River ranges as a cowboy, wagonboss, and rancher since about 1890. He had a vivid memory of the region and remembered that Grape Creek was the site of their first night stop when traveling via horseback or wagon from San Angelo. There was a deep hole at the campsite, a welcome fishing and swimming place. Mims once caught an 18-pound catfish in the hole on an overnight camp.

Today, Grape Creek is a dry creek bed; the springs have ceased to flow.



Te 91-1 - Grape Creek as it looks today at the old campsite on the San Angelo road. The deep waterhole is dry and filled with gravel. The skeletons of the dead pecan trees stand as mute testimony to a dying stream.

Te 234-4 - Stump
of a dead willow tree
and rotted posts of
wooden windmill
tower mark the site
of one of the head
springs of Grape
Creek. The mill
was used to boost
water to the
ranch headquarters.
The spring stopped
flowing in 1918-19.



The same thing has happened to most of the main springs on the North Concho River.

Te 91-4 - Shelving
Rock Spring used
to flow from under
these rock ledges
and was the main
water supply for
the J. M. Mims
Ranch. This spring
ceased to flow
many years ago. After
large areas of
range were cleared
of brush, the spring
has again begun to
flow.



The springs on the North Concho River have failed because the aquifers are no longer being recharged.

With a thick cover of grass that originally grew on the Concho River watershed, most of the rainfall was absorbed. A portion of it percolated downward into the aquifers which fed the springs.

Heavy grazing, uncontrolled prairie fires, and drought removed the protective grass cover. Mesquite, lotebush, catclaw and other undesirable woody plants moved in and now dominate much of the watershed. Some of the rainfall from heavy rains runs off to produce flash floods. Most of the water that is absorbed by the soil is lost by evaporation from the bare surfaces, or is used by the woody plants. The deep-rooted shrubs reach deeply into the soil to intercept percolating waters. Little or no water succeeds in moving downward into the aquifers.

Failing springs, not only in the North Concho watershed, but all over the state are a tragic and evil omen. The dying springs and streams indicate a decline in our water balance in the bank - the underground reservoirs from which the springs flow.

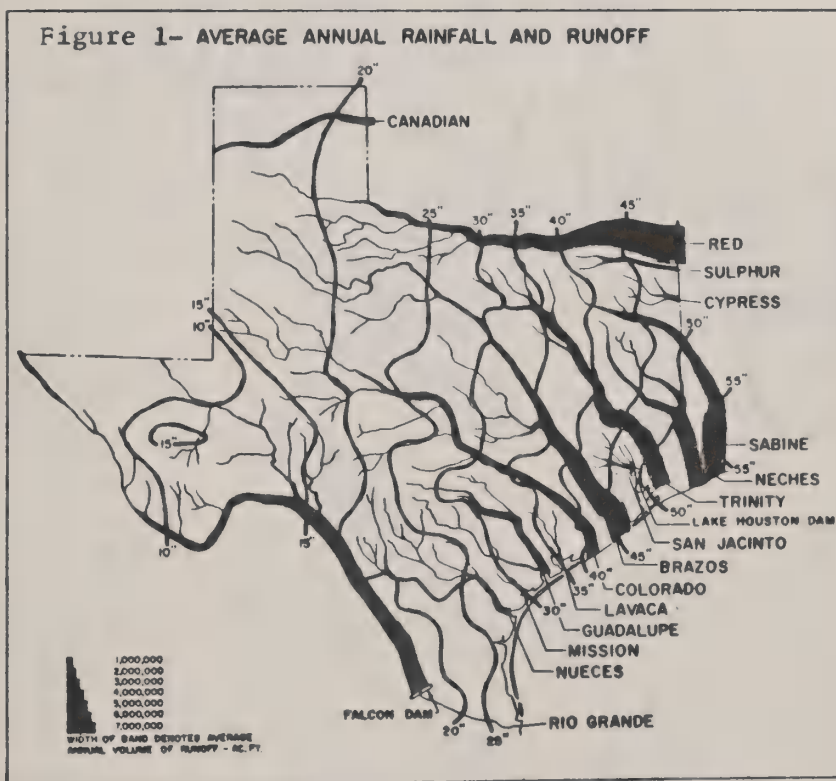
The infestation of brush and wastage of water on Texas rangelands is affecting every citizen of the state who is interested in conserving its most valuable resource - water!

POSSIBLE EFFECTS OF GRASSLAND RESTORATION ON WATER YIELDS

There is no doubt but that the control of undesirable woody plants and weeds and their replacement by nutritious grasses would save enormous amounts of water for other uses.

Opportunities and problems associated with a control program for increasing water yields vary in different parts of the state with rainfall, soils, vegetation, and other factors. Therefore, the opportunities for saving water will be discussed on the basis of land resource areas (Figure 2) and watersheds and rainfall zones (Figure 1).

It must be made clear that not all woody plants are undesirable and a grassland restoration program in no wise is directed towards total elimination of woody plants! Many woody plant species provide food and cover for wildlife and livestock. Others have value for recreation and beautification purposes. These needs must be considered in any practical grassland restoration program. It would be unwise and uneconomical to attempt to control all the woody plants in the state. Large amounts of water can be saved and all other practical uses of woody plants satisfied by a judiciously planned and applied program of control.



From: WATER DEVELOPMENTS AND POTENTIALITIES OF THE STATE OF TEXAS,
A joint report prepared by the Bd. of Water Eng., State of Texas; SW Div Corps of
Eng., US Army, Bur of Reclamation, and Soil Conservation Service.



Figure 2
MAJOR WATERSHEDS AND LAND RESOURCE AREAS
TEXAS

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATING WITH
THE TEXAS AGRICULTURAL EXPERIMENT STATION

EAST TEXAS TIMBERLANDS

Opportunities for mcreasing water supplies by manipulating plant cover are probably greater here than in any other portion of the state, because rainfall is higher and there is a larger growth of vegetation consuming greater amounts of water.

Precipitation in the East Texas Timberland area ranges from 30 to 55 inches annually. Most of that portion receiving 40 or more inches of rainfall originally supported a pine and hardwood forest. Much of the forest, however, has been removed or cut over. Many areas were cleared and cultivated and later abandoned. Large areas are now grown up in worthless woody plants. It is in these stands of worthless plants that opportunities exist for increasing water yields with a control program.

The portion of the East Texas Timberlands area having less than 40 inches rainfall formerly was a post oak-blackjack oak savannah with mottes of trees interspersed with open areas of tall grass prairie. On most of these lands, the oaks and associated species have increased to form dense thickets producing very little marketable wood products and limited forage for livestock or deer. In addition, a great many tracts on which farming has been discontinued have become heavily infested by such woody plants as elm, yaupon, huisache, and others.

Table 3. Major Woody Plants (Other than Timber Trees) of the East Texas Timberlands Land Resource Area.

Name	Acres by Density Class *		
	Light	Medium	Dense
All woody plants	764,000	887,900	4,329,500
Post and blackjack oak	337,000	707,100	3,704,300
Yaupon	615,900	535,300	922,200
Persimmon and sassafras	247,000	119,000	21,000
Elm	1,275,300	193,000	221,700
Juniper	881,500	155,600	50,800
Live oak	168,400	92,400	109,500
Macartney rose	35,000	17,000	16,000

* Several species may occur in mixed stands so acres are duplicated. Also, two or more species in light stands may comprise a total dense stand.

This table shows approximately 5,217,400 acres with a dense or medium stand of woody plants other than timber trees. If 30 percent of this land was left untreated for use by wildlife or for recreation and beautification, about 3,650,000 acres could be treated for grassland restoration and increased water yields.



Te 6663-11 - Restoring brush infested land like this to grasses will save millions of gallons of water per acre treated for other beneficial uses.



Te 6663-8 - Grass uses less water than brush, protects the soil and helps to absorb the rains. Trees are left for shade and wildlife cover.

It is estimated that about 3,000,000 acres of the land that could be treated is located in the Brazos River watershed and eastward, and receives more than 35 inches of rainfall annually.

Marston working in similar hardwoods estimated that 6.4 inches additional streamflow could be obtained by converting brushy land to grass. (13) His estimate should be applicable here since the areas are very similar.

A grassland restoration program applied on 3,000,000 acres could be expected to save about 1,600,000 acre-feet of water in this part of the East Texas Timberlands.

The remaining 650,000 acres of brushy land needing treatment is located west of the Brazos River watershed, and receives less than 35 inches of rainfall. Because of the lower rainfall, it is estimated that less water, perhaps about 4 inches, could be saved per acre treated. Replacing the worthless brush with grass would probably save about 217,000 acre-feet of water west of the Brazos River watershed.

A total saving of about 1,817,000 acre-feet of water could be expected from a grassland restoration program in the East Texas Timberlands area. No estimate for water that could be saved from clearing areas of timber trees been made, though investigators have shown that additional water could be saved by clearing forests from watersheds.

The water saved by brush control would be distributed by watersheds as follows:

Table 4 - Expected Increase in Water Yields by Watersheds, East Texas Timberlands

River	Acre-feet
Brazos	590,000
Trinity	385,000
Red	305,000
Sabine - Neches	290,000
San Jacinto	30,000
Colorado	124,000
Guadalupe - San Antonio	93,000
	<hr/> 1,817,000

BLACKLANDS AND GRAND PRAIRIE

These two land resource areas are grouped together because of similarity in soils and climate. The average annual rainfall ranges from 30 to 45 inches. The soils are mostly fine textured, derived from limestones and marls, and are slowly permeable. The original vegetation consisted primarily of tall and mid grass prairie with some oak savannah on the uplands and hardwood trees along the streams.

Mesquite has invaded into nearly all the grasslands. Junipers, once growing principally on shallow ridges, now have spread over much of the grasslands of the Grand Prairie. Elm has become a problem in the eastern parts. The oaks, originally growing as scattered trees and mottes, now have thickened to dense stands on many acres.

Table 5 - Major Woody Plants of the Blacklands and Grand Prairie Areas

Name	Acres by Density		
	Light	Medium	Dense
All woody plants	1,380,700	1,541,400	3,505,300
Mesquite	1,115,900	688,300	707,300
Junipers	736,500	345,700	622,300
Live oak	1,195,200	764,300	133,000
Shin oak	161,500	70,300	104,300
Post oak	568,800	582,600	579,100
Cactus	968,100	152,000	76,000
Elm	277,500	148,000	412,300

Brush control as part of a grassland restoration program should be applied on at least 70 percent of the medium and densely infested lands, or on about 3,500,000 acres. The soils of the Blackland and Grand Prairie regions are finer textured and less permeable than those of the East Texas Timberlands, and less water could be expected to percolate into the underground aquifers. It is believed, therefore, that less water could be saved by a control program on these soils than on the East Texas Timberland soils in the same rainfall zone. Therefore, it is estimated that at least three inches of water could be saved by replacing the woody growth with grass cover. This would result in a total saving of 875,000 acre-feet in the Blackland and Grand Prairie land resource areas.

Table 6 - Expected Increase in Water Yield by Watersheds, Blackland and Grand Prairie Land Resource Areas.

River	Acre-feet
Brazos	455,000
Colorado	140,000
Trinity	131,000
Guadalupe - San Antonio	96,500
Red	35,000
San Jacinto	17,500
	875,000

NORTH CENTRAL PRAIRIE - CROSS TIMBERS - CENTRAL BASIN

The average annual rainfall in these three resource areas ranges from 25 to 35 inches. The original vegetation was mostly a savannah of post oak and associated woody plants interspersed with open areas of tall and mid grass prairie.

The original grass in these savannah-type grasslands has largely been replaced by woody vegetation. Tree stands have greatly thickened, and mesquite and other brushy species now occupy much of the formerly open prairie. Mesquite and other brush have taken over much land once cultivated. Whitebrush is becoming a serious pest in the Central Basin.

Table 7. - Major Woody Plants of the North Central Prairie, Cross Timbers, and Central Basin Land Resource Areas

Name	Acres by Density		
	Light	Medium	Dense
All woody plants	384,000	874,200	4,367,600
Post oak and others	733,800	632,500	1,362,600
Mesquite	900,400	1,421,500	1,793,600
Junipers	805,000	326,900	170,400
Cactus	1,568,100	194,100	26,600
Whitebrush	652,900	235,300	281,900
Live oak	735,800	588,100	74,600
Saltcedar	800	1,000	23,000



Te 5448-5 - Post oak that once grew in an open stand has thickened to a dense stand on more than a million acres. There is little or no usable forage produced here. All the soil and water resources are being wasted.



Te 2527-12 - Dense post oak was sprayed and then chained four years later for control. The newly treated area was rested from grazing for a growing season to permit recovery of grass and then conservatively grazed. On lands treated like this, most of the rainfall is being used to produce grass and some is percolating into the underground strata. Some shrubs and mottes of trees are left for wildlife and livestock shade and cover.

At least 70 percent of the grasslands infested with medium to dense stands of woody plants should be treated, a total of at least 3,670,000 acres.

The vegetation and soils of these land resource areas are somewhat similar to those of the area studied by Marston (Cit. 13, page 23). However, since annual rainfall is about three-fourths that of the site of Marston's study, it is assumed that there would be a lower potential saving of water, about 4 inches, following grassland restoration. Four inches saved on 3,670,000 acres treated represents a total saving of 1,223,000 acre-feet annually.

Saltcedar is becoming a serious pest on the streams of Northwest and West Texas where it is rapidly spreading and increasing. Gatewood and associates (Cit. 12, page 14) found that saltcedar will steal as much as 5 to 7 acre-feet of water annually when growing on sites having high water tables or along streams. They also found that phreatophytes such as saltcedar on 9,303 acres of the Salt River bottomlands of Arizona used 28,000 acre-feet of water annually, or about 3 acre-feet per acre infested.

Young and Blaney found that bermudagrass used only about 28.2 inches of water annually when growing on bottomland sites. (14) Most investigators have found that native grasses use even less water than does bermudagrass.

(14) A. A. Young and H. F. Blaney - USE OF WATER BY NATIVE VEGETATION, Calif. Dept. of Public Works, Div. Water Resources Bul. 50, 1942

Eradication of saltcedar is needed on 24,800 acres along the Red and Brazos Rivers. It could be reasonably expected that as much as three acre-feet of water could be saved by eliminating saltcedar on the stream courses, and at least one acre-foot where it is growing on bottomlands, and replacing it with grass. If half of the saltcedar is growing on stream channels and half on bottomlands, a total of 49,6000 acre-feet of water could be saved by eradication and grassland restoration.

The total saving for these three land resource areas equals 1,272,600 acre-feet which would be distributed by watersheds as follows:

Table 8 - Expected Saving of Water by Watersheds, North Central Prairie, Cross Timbers, and Central Basin Areas.

River	Acre-feet
Brazos	473,900
Colorado	404,000
Red	211,700
Trinity	183,000
	<hr/> 1,272,600

EDWARDS PLATEAU

The Edwards Plateau land resource area is an important water contributing area for the Colorado, Guadalupe, San Antonio and Nueces Rivers, and contributes to the flows of the Rio Grande and Pecos Rivers. It is an extremely variable area in vegetation and climate, with rainfall of 35 inches annually in the eastern side, decreasing to about 15 inches at its western end.

The original vegetation of the Edwards Plateau consisted of a live oak-shin oak-tall grass savannah at the eastern side gradually changing with decreasing annual rainfall to a desert plains grassland with low shrubs in the western part.

Most of the woody plants have greatly increased in density, and the grass cover has been seriously reduced. Ninety-seven percent of the area is now infested with woody plants, and 51 percent with dense stands. Live oak has greatly thickened in stands, and scrub tree thickets have replaced many of the stately giants that once characterized most of the eastern Edwards Plateau. Junipers have thickened to dense "cedar brakes" in large parts of the plateau. Cactus, Texas persimmon, mesquite, and many other species have become serious problems.

Te 5344-3 - (Right)
 Very little grass
 or other forage
 plants can grow in
 dense "cedar
 brakes" like this.
 Almost two million
 acres in the Edwards
 Plateau are covered
 with dense juniper
 stands.



Te 5346-5 (Left)
 Mesquite, lotebush,
 and cactus form an
 almost impenetrable
 thicket in this val-
 ley site where good
 forage should be
 growing.

Te 6663-15 (Right)
 Cactus, Texas
 persimmon (In cen-
 ter of picture) and
 juniper here occur
 in a thicket. Most
 of the rainfall is
 used to grow
 worthless plants.
 Almost eleven mil-
 lion acres of the
 Edwards Plateau
 are covered with
 dense brush.



Table 9 - Major Woody Plants of the Edwards Plateau *

Name	Acres by Density		
	Light	Medium	Density
All woody plants	1,563,300	9,050,000	10,968,900
Mesquite	6,107,900	3,884,500	1,907,200
Junipers	5,796,600	5,349,400	1,885,900
Live oak	4,466,200	4,264,600	784,600
Shin oak	3,815,700	722,700	154,100
Cactus	14,509,200	878,400	137,300
Post oak	1,073,000	130,400	11,400
Whitebrush	322,000	153,800	49,200
Saltcedar		7,000	28,300

* Many other species, such as Texas persimmon, mesquite, guajillo, lotebush, coyotillo, catclaw acacia, and creosotebush are important locally but not shown in this table. They are included in the "All woody plants".

Many of the woody plants of this area, such as the oaks, guajillo, and others, provide valuable food and cover for wildlife, and browse for domestic livestock. In fact, it is the rich abundance and variety of forage plants that made the Edwards Plateau one of the leading goat and sheep raising regions of the nation. The abundance of browse plants has made this also an excellent deer producing section. A substantial percentage of the better kinds of browse plants should be left during a grassland restoration program.

There is such a great variation in the kinds of vegetation, climate, and the potential for saving water from brush control that estimates will be made separately for the eastern, or higher rainfall, and the western parts of the Edwards Plateau.

It is estimated that an average annual increase of 3 inches of water can be obtained through a judicious practical grassland restoration program in the eastern Edwards Plateau. This estimate is based in part on the work of Woods who calculated that increases of 5 to 15 percent of the annual rainfall could be saved from brush manipulation on pinon-juniper-shrub oak watershed in California where the total annual rainfall was similar to this region. (15) Pase and Ingebo, also in California, determined that water yields were increased by 3 inches per year following control of chaparral brush including shrub oaks on a watershed receiving from 20 to 30 inches of precipitation annually. (16)

If excess brush on 70 percent of the eastern Edwards Plateau, or on 5,500,000 acres, were controlled, and the 3 inches of water saving realized, this would amount to a total saving of 1,375,000 acre-feet of water annually. This percent of treatment would leave ample amounts of desirable woody plants for wildlife and livestock, and for beautification and recreation purposes.

(15) Lowell G. Woods - JOUR OF SOIL AND WATER CONS. Vol 21, No. 3, 1966

(16) C. P. Pase and P. A. Ingebo - PROC OF ARIZ. WATERSHED SYMPOSIUM, 1965



Te 1884 - Thinning the brush and replacing it with high quality grasses as shown here on this Edwards Plateau range can be expected to save 3 inches water annually. Ample amounts of browse plants are left.

In the western Edwards Plateau, expected saving of water would be much less because of the limited rainfall. In many years, all or most of the moisture will be used by the vegetation and none will run off, or be available to percolate into the aquifers. Based on studies in Arizona and other low rainfall areas, a grassland restoration program on the uplands could save an average of about 0.3 inch inch per year. (17 and 18) Therefore, if 8,500,000 acres were treated, a saving of 212,500 acre-feet could be expected.

Additional water could be saved by eradication of saltcedar on the Pecos River. Most of this phreatophyte is growing along the channel where it is drawing water directly from the stream. Therefore, it is estimated that at least 3 acre-feet of water could be saved per acre treated, or 105,900 acre-feet.

Table 10 - Water Saved by Watersheds, Edwards Plateau Land Resource Area

River	Acre-feet
Eastern Edwards Plateau	
Colorado	715,000
Guadalupe-San Antonio	330,000
Nueces	330,000
Western Edwards Plateau	
Colorado	70,000
Rio Grande - Pecos	248,400
	<hr/> 1,693,400

(17) Howard L. Gary - The Effects of Varying Plant Densities on Water Yield and Erosion as Determined by a Lysimeter Study in Central Arizona - Thesis for M.S., Texas A & M Univ., 1961

(18) C. P. Page - AM ASSOC ADV OF SCIENCE - Rocky Mt and SW Div. Contrib. 8:31-40, 1966

ROLLING PLAINS

The Rolling Plains land resource area is an important water contributing region for the Colorado, Brazos, Red and Canadian Rivers. The average annual rainfall ranges from 20 to 25 inches. The area was originally covered by a grass cover with a few scattered trees on the uplands, and bands of woody vegetation lining the streams. Narrow and occasionally large areas of deep sands are generally found adjacent to the stream valleys, on which tall grasses dominated in a mixture with shin oak and sand sagebrush.

Woody plants have increased tremendously in this area as heavy grazing use reduced the grass cover. Almost 15 million acres, 81 percent, of the grasslands are now infested with woody plants, 48 percent or 8¼ million acres densely infested.

Te 7065-10 -
Mesquite, often associated with
lotebush, cactus,
and other shrubs,
is now found on
10.5 million acres.
It is rapid-increasing.
Note the many small
plants in this
pasture.



Te 5447-3 Shin oak
and sand sagebrush
have taken over
large areas of deep
sands. Most of the
rainfall on this site
is being used to pro-
duce woody plants
of low forage value.

Table 11 - Major Woody Plants in the Rolling Plains Land Resource Area

Name	Acres by Density		
	Light	Medium	Dense
All woody plants	2,003,700	4,673,100	8,259,100
Mesquite	2,184,400	4,182,300	4,164,600
Shin oak	402,600	215,800	746,200
Sand sagebrush	1,582,500	1,292,000	616,500
Cactus	1,825,800	435,800	231,600
Junipers	630,500	1,401,300	663,200
Saltcedar	120,200	77,800	89,700

* Other locally important species not shown as separate acreages are lotebush, yucca, and catclaw acacia.

Exclusive of the shin oak, sand sagebrush, and saltcedar, there are about 10,600,000 acres of the Rolling Plains grasslands moderately or densely infested with some kind of brush, with mesquite the most abundant. Most of these woody plants are aggressive invaders, have little or no browse or wildlife value, and should be controlled. Saltcedar is a very aggressive invader on the major streams and is becoming a most serious problem to water users.

A grassland restoration program should include control of at least 90% of the worthless woody plants and replacing them with grass. Saltcedar should be eradicated in so far as is possible.



Te 5447-3 - This was once a mesquite-infested range. The mesquite was controlled by rootplowing, and the area seeded to native grasses. The grass cover uses less water than the brush, and forage production is much improved.

Pase estimated that water yields from the short grass plains of Arizona totaled from 0.1 to 0.5 inch per year. (Cit. 18, page 30). Rainfall in the Rolling Plains of Texas is somewhat higher than in the Arizona short grass country. Therefore, it is estimated that replacing the mesquite and other brush with grass should result in a saving of at least one acre-inch annually on the fine textured soils.

A large amount of the rainfall on the deep sands should be absorbed, some of it to percolate into the underground strata, later to emerge as seeps and springs. It is estimated that the dense shin oak-sagebrush stands on the sands use almost as much water as the post oak thickets of the North Central Prairie. Replacing the shrubs with grass should save at least 4 inches of water.



Te 4575-4 Sagebrush was controlled by spraying and the pasture rested to permit the grasses to recover on this sandy rangeland near Wheeler. The improved range is now producing high quality forage, and very little water is being wasted in producing worthless plants or from surface evaporation. The cover has been found to be favorable habitat for prairie chicken.

The total water saved by a range improvement program in the Rolling Plains would go far in improving the water situation on the major streams of the area. A saving of one inch on 90 percent of the mesquite-infested lands indicates a possible saving of 795,000 acre-feet. Four inches saved on 70 percent of the densely and moderately thick stands of shin oak and sagebrush represented a potential of 817,000 acre-feet annually. If half of the saltcedar is growing directly on the streams and half on the bottomlands, representing possible saving of three and one acre-feet respectively, 575,400 acre-feet of water could be saved by a comprehensive grassland restoration program in this land resource area.

Table 12 - Expected Annual Saving of Water by Watersheds, Rolling Plains.

River	Acre-feet
Brazos	495,500
Colorado	443,500
Red	835,000
Canadian	413,000
	<hr/> 2,187,400

HIGH PLAINS

The average annual precipitation on the High Plains of Texas ranges from 15 to 20 inches. The area consists of an almost level tableland, with numerous playa lakes. Although the head drainages of the Colorado, Brazos, and Red River arise on the High Plains, most of the runoff drains into the playa lakes, and there is little direct runoff into the major streams.

The deep sandy soils of this area are the major recharge areas for the important underground reservoirs of the Ogallala geological formation from which much of the irrigation water is pumped. Most of the water not used by plants or lost by evaporation percolates into the underground aquifer.

The original vegetation consisted of mixed grass plains on the fine textured soils, and a mixture of mid and tall grasses with shin oak and sagebrush on the deep sands.

Mesquite has now invaded into more than 51 percent of the grasslands. Shin oak and sagebrush have become dominant on most of the sandy rangelands.

Table 13 - Major Woody Plants of the High Plains

Name *	Acres by Density		
	Light	Medium	Dense
All woody plants	609,200	1,378,000	2,714,000
Mesquite	923,900	1,632,600	782,000
Shin oak	49,500	311,200	1,414,700
Sand sagebrush	655,000	281,900	85,400
Cactus	217,000	18,000	1,000
Saltcedar	1,000	1,700	3,000

* Yucca, catclaw acacia, and sumac are important locally.



Tex 40,937 Control of the shin oak and sagebrush on the sandy soils has great potential for saving water. The deeply penetrating roots of the brush intercept water that would otherwise percolate into the aquifers. A brush control program would add materially to the amount of water entering the aquifer.

Rowe and Reimann reported that no water percolated beyond a 12 foot-depth on brush covered plots in the San Dimas Forest of California (19). However, 6.4 inches percolated beyond 12 feet under grass cover, with 24.9 inches of precipitation.

Rich found on permeable soils of the Sierra Ancha Forest Experiment Station of Arizona that 1.07 inches of water percolated beyond a 12-foot depth under a grass cover with 26.33 inches of rainfall. (20)

It is estimated that an average of at least 2 inches of water could be saved annually by controlling shin oak and sagebrush. Because of the wildlife and browse value of these species, it is suggested that only 70 percent of the medium and dense infestations be controlled. Therefore, if 1,200,000 acres were treated, and a saving of 2 inches realized, a total annual saving of 200,000 acre-feet could be achieved.

Mesquite is most abundant on the heavier soils of the High Plains. These soils are less permeable than the deep sands, and less water percolates into the underground aquifers. Gary working on desert plains grassland with rainfall and soils somewhat similar to that of the High Plains of Texas, found that deep percolation and runoff water yields were low. He estimated that between 0.1 and 0.5 inch of water was the annual yield (Cit. 17, page 30).

On the basis of Gary's information, it is estimated that 0.3 inch of water could be saved each year by treating the mesquite on the heavier soils. Since the mesquite has almost no value, a high percentage should be treated. If 3,000,000 of the 3,338,500 infested acres were treated, a total saving of 75,000 acre-feet could be expected.

Saltcedar grows along some of the major drainageways, such as Sulphur Creek, Whitehorse Creek, and around some playa lakes, generally where permanent water is present. All of it should be eradicated as rapidly as feasible because of its aggressiveness. It is believed that about 3 acre-feet of water could be saved for each acre treated, or a total of 17,100 acre-feet.

The total water which could be saved through a grassland restoration program on the High Plains amounts to approximately 292,100 acre-feet. Most of this water would percolate downward to add to the water stored in the deep aquifers from which it could be pumped and add to the supply available for municipal and irrigation uses. Only small portions would be direct runoff to add to the surface flow of the major streams.

(19) P. B. Rowe and L. F. Reimann - JOURNAL OF FORESTRY, March, 1961

(20) L. R. Rich - PROC OF AM SOC OF CIVIL ENG., Vol 77, Oct. 1951

TRANS-PECOS

The Trans-Pecos land resource area is in the more arid part of Texas. The average annual precipitation is generally less than 18 inches, and large portions receive less than 10 inches. The largest portion of the area has a desert or desert plains grassland vegetation with creosotebush, tarbush, and cactus the dominant plants. Mesquite is a problem on large areas, and becomes quite dense on the bottomland overflow areas. Saltcedar is thick on most streams. The brush survey made by the Soil Conservation Service revealed that 90 percent or 15,157,000 acres, of rangelands were infested with woody plants.

A grassland restoration program offers only limited opportunities for increasing or saving water in these semi-arid and arid lands. A program involving expensive brush control operations is not currently feasible on most of the uplands because of the low rainfall, low productivity, and high cost of the treatment. It is believed that not more than 1,000,000 acres (other than saltcedar infested lands) could be treated for brush control. This is confined to areas of higher rainfall, or where extra water makes grass recovery possible.



BEFORE

AFTER

Te 1102-7 and 1102-8 - Denuded rangelands of the Trans-Pecos (left) were rootplowed and seeded to restore the grasses. A good stand of grasses now (right) are using water formerly wasted in the production of brushy plants.

In this area of low rainfall, all of the moisture is used in most years by the vegetation and it is only in wet years, or during heavy rainfall that any of it percolates into underground strata. A grassland restoration program would materially improve the forage production, but would save only small amounts of water. Based on the work by Gary (Cit. 17, page 30), it is estimated that about 0.1 inch of water could be saved on treated areas. If 1,000,000 acres were treated, this would save a total of about 8,300 acre-feet.

The biggest potential for saving water lies in the control of saltcedar on 281,600 acres along the Rio Grande and Pecos Rivers. It is estimated that probably half of this is growing on stream channels and canals where it is drawing water directly from water courses or tables. With an estimated saving of one acre-foot on that portion growing on bottomlands, and three acre-feet where it is growing on the stream courses, treatment would save a total of 563,200 acre-feet of water in the Trans-Pecos area.



Te 5573 - A thick growth of saltcedar on the Pecos River draws from 5 to 7 acre - feet of water per acre of infestation from the stream.

At least 571,500 acre-feet of water could be saved by a grassland restoration program in the Trans-Pecos land resource area. All of this area is in the Rio Grande-Pecos River watershed.

RIO GRANDE PLAIN



Te 3236-10

The Rio Grande Plain land resource area contains the greatest concentration of brush in the state, both in kinds and density. A high percent of the rainfall of 18 to 35 inches is presently being used to produce worthless or low woody plants.

The following table shows the brush infestation by major watersheds:

Table 14 - Acreage Brush Infestation by Watersheds of Rio Grande Plain

Name	Acres of Density		
	Light	Medium	Dense
Nueces	202,500	643,200	6,134,500
Guadalupe - San Antonio	102,000	240,700	598,000
Rio Grande	184,400	334,500	2,545,700
Intervening Areas	809,500	884,700	2,841,000



Te 254-8 (Above)
Grassland restoration
in the Rio Grande
Plain would replace
the water robbers,
brush, with palatable
grasses, which use
less water than the
brush.



Te 4221-9 (Left)
Sufficient brush
would be left to
furnish browse
and cover for deer
and other wildlife.
It would be left as
scattered plants,
mottes, or in strips.

Soils and geological formations of the Nueces and Guadalupe-San Antonio portions of the Rio Grande Plain are generally not as permeable as those of the Edwards Plateau where a three-inch saving was estimated. Also, rainfall is less than for the area to the east where a saving of four inches was calculated. Therefore, a saving of two inches on land restored to grass in this portion of the Rio Grande Plain should be a reasonable expectation, and perhaps rather conservative because of the extreme density of the brush.

Controlling brush and replacing it with grass on 70 percent of the dense and medium stands of brush, or 4,57,000 acres of the Nueces watershed, and 587,000 acres of the Guadalupe-San Antonio watershed, is needed. This treatment should realize a saving of 791,700 acre-feet in the Nueces River watershed, and 98,000 acre-feet annually in the Guadalupe-San Antonio watershed. Treatment is also needed on 2,608,000 acres of the intervening areas, those areas not contributing to the major river watersheds. Treatment would result in saving 434,700 acre-feet. Some of this water would recharge the underground reservoirs and be available for local pumping.

That portion of the Rio Grande Plain draining into the Rio Grande has an annual precipitation of only 18 to 22 inches. There is less opportunity for saving water than in the eastern part where rainfall is higher. Replacing brush with grass should save about 0.3 inch, similar to the western Edwards Plateau. If 70 percent of the medium and densely infested land were treated, or about 2,016,000 acres, 50,400 acre-feet of water could be saved. This would all be in the Rio Grande watershed.

Table 15 - Expected Annual Water Saved by Grassland Restoration, Rio Grande Plain

Watershed	Acre-feet
Nueces	791,700
Guadalupe - San Antonio	98,000
Rio Grande	50,400
Intervening areas	434,700
	<hr/> 1,374,800 <hr/>

COAST PRAIRIE

Rainfall in the Coast Prairie land resource area ranges from 30 to 55 inches from west to east. The original vegetation on uplands was mostly a tall grass prairie, with some live oak and post oak savannahs on sandy soils. Dense hardwoods dominate the bottomlands.

Woody plants such as huisache, mesquite, macartney rose, and baccharis have invaded much of the open grasslands. The oaks and associated species have thickened and now form dense woodlands of little value on many former savannahs.



Te 6252-15 -
Huisache is an important invader in the Coast Prairie. It is rapidly spreading and increasing on native grasslands, and is a problem on improved pastures.

Table 16 - Major Woody Plants of the Coast Prairie

Name	Acres by Density		
	Light	Medium	Dense
All woody plants	272,900	180,700	572,600
Huisache and retama	231,100	121,300	34,800
Mesquite	163,000	43,500	1,000
Live oak	97,400	113,300	162,300
Post oak	59,700	75,800	37,700
Yaupon	55,200	94,900	29,700
Macartney rose	77,900	50,700	25,900



Tex 49-097 - Grass-land restoration in the Coast Prairie should provide for opening up dense stands of oak, and controlling such aggressive invaders as huisache, macartney rose, and mesquite. Mottes and strips will be left for wildlife cover.

Te 6605-6 - Once the trees and brush are reduced, grass can make good improvement if properly grazed. This range near Victoria was rested two summers following brush treatment. Rainfall is now being used to produce forage.



The amount of water that can be saved by controlling undesirable brush will vary from east to west because of differences in rainfall and soils.

Treatment of the bottomlands can be expected to save the most water because of the large water consumption by bottomland vegetation. Gatewood and associates reported that trees on bottomlands used 40 inches annually. (Cit. 12, page 14). Bermudagrass on similar sites was found to use only about 28 inches of water. (Cit. 14, page 26 - Young and Blaney) This indicates that 12 inches of water could be saved per acre of bottomland treated.

At least 5,000 acres of bottomlands, should be treated on each of the three rivers, Trinity, Brazos, and Colorado. With a saving of one acre-foot per acre treated, 15,000 acre-feet of water could be made available for more beneficial uses.

Water saved on the uplands would be somewhat less than on the bottomlands. The eastern part of the Coast Prairie is similar in rainfall, soils, and vegetation to the eastern East Texas Timberlands area. Therefore, it is estimated that water saved from a control program would be similar to that area, or about 6.4 inches. By replacing non-economic woody vegetation with grass on 70 percent of the dense and medium dense stands of brush, or on 21,200 acres east of the Brazos-Colorado River divide, about 118,000 acre-feet of water could be saved.

The portion of the Coast Prairie located west of the Brazos-Colorado River divide, having less rainfall, would have lower consumption of water by woody vegetation. It is estimated that water consumption could be reduced by about 4 inches. Restoring the grasses on 70 percent of the densely and moderately densely infested lands, or on about 296,000 acres, with a saving of 4 inches, could result in a total saving of 98,700 acre-feet.

A total of 231,700 acre-feet of water could be realized from a grassland restoration program in the Coast Prairie. This would be distributed by water sheds as follows:

Table 17 - Probable Water Saved by Watersheds, Coast Prairie

River	Acre-feet
Sabine - Neches	1,200
Trinity	5,000
San Jacinto	1,900
Brazos	21,400
Colorado	13,400
Guadalupe - San Antonio	28,700
Intervening areas	<u>160,100</u>
	231,700

A PROGRAM TO SAVE WATER

An enormous amount of water could be saved by replacing the water-hogging undesirable woody plants with grass under an all-purpose grassland restoration program. Figure 3 shows how much water could be saved by controlling brush in the various parts of the state. The saving from saltcedar control is not shown on this map since this plant is distributed as narrow bands along most of the major streams in West Texas.

The following table summarizes by watersheds the total possible saving:

Table 18 - Estimated Water Saved by Major Watersheds

Name of Watershed	Acre-feet Water
Canadian	413,400
Red	1,386,700
Brazos	2,035,800
Colorado	1,909,900
Trinity	704,000
Sabine - Neches	291,200
San Jacinto	49,400
Rio Grande - Pecos	799,700
Nueces	1,121,700
Guadalupe - San Antonio	646,200
Other areas:	
High Plains	292,100
Gulf Coast intervening areas	594,800
Total	10,244,900

It is believed that about ten million acre-feet is a conservative estimate, a saving which should be achieved with a sound program taking into consideration all needs. This amount is about three-fourths as much water as the present annual consumption by municipal, industrial, and irrigation uses, and an amount that would go far in meeting future needs.

Johnston estimated that 100,000,000 acre-feet is lost by soil evaporation annually in addition to that used by weeds and woody plants. (Table 1, page 3) A grassland restoration program would not only reduce the waste by worthless plants, but the improved ground cover would help to absorb the rainfall, and reduce surface evaporation losses. If this loss could be reduced by only 5 percent, there would be an additional saving of 5,000,000 acre-feet of water - water that would be available for deep percolation and for improved forage production.

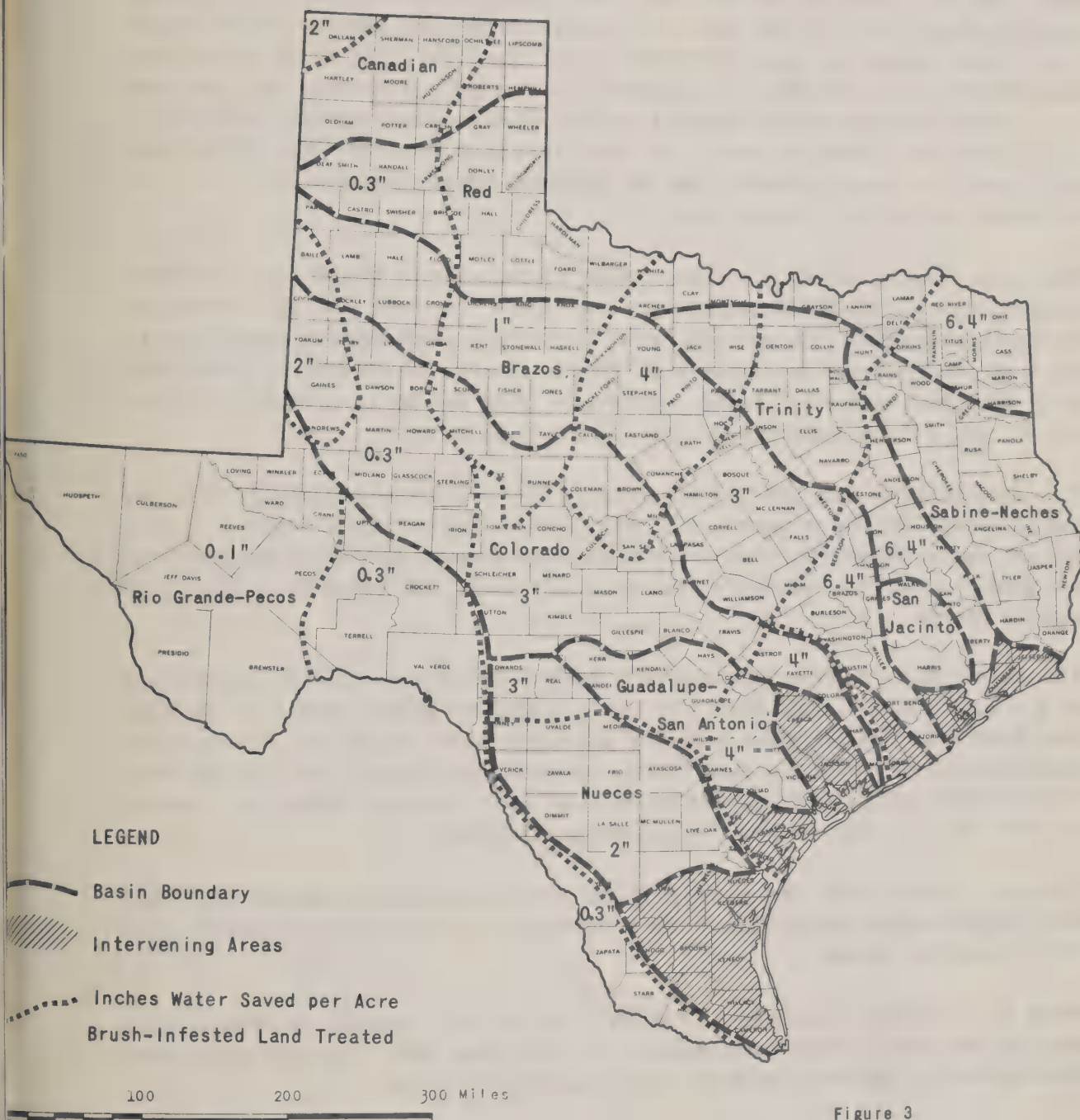


Figure 3
 EXPECTED BENEFITS OF GRASSLAND RESTORATION
 TEXAS
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE
 TEMPLE, TEXAS

4-67 4-L-23890

Base 4-L-15782A

The cost of treatment is an important item in the program to improve the grasslands and save water. It is estimated that initial costs will range from \$3 to \$50 per acre, probably averaging about \$10 to \$15 per acre. If 70 percent of the more densely infested brushlands were treated, or about 40,000,000 acres, the total cost would approximate \$400,000,000 to \$600,000,000. This appears at first sight a tremendous cost, but when it is realized that 10-¼ million acre-feet of water would be saved annually, and the cost is amortized over a five-year period, the annual cost is no more than \$8 to \$12 per acre-foot saved. The benefits derived from the improved forage production would alone go far to balance the cost of the program.

There will also be a need to maintain control of the brush on treated land. Treatment presently being used seldom eradicates all the brush, and there will be a continuous source of reinfestation from untreated areas. Therefore, a comprehensive control program will of necessity provide for maintenance. This may be applied annually, or periodically every few years as needed. Annual maintenance costs will be considerably less than initial costs, and will probably range from \$0.25 to \$1.00 per acre.

It is recognized that more effective and certainly more economical methods of control are badly needed. Methods of control, if properly applied, are generally effective to most species, but inadequate for some species. Research properly oriented to the needs can aid greatly to improve treatment effectiveness and costs, and should be a step in the over-all program.

The citizens of Texas have become acutely aware of their water resources, and the lack of it in many places. A State Water Plan has been proposed by the Texas Water Development Board which involves many reservoirs and diversions at a huge cost. The reservoirs and diversions are only a part of the needs, however. There needs to be a plan for treatment to assure that the water reaches the reservoirs and diversions. Water that is wasted by brush and weeds can't be stored or diverted to needy areas.

The cost of saving water through the grassland restoration program compares quite favorably with the cost of storing water in the State Water Plan. The cost of the latter is about \$55 per acre-foot storage.

Water is an absolute necessity. The writer of the article, "What Price Water?", in a report of the American Waterworks Association, stated that water is beyond price - when shortages occur, men will fight wars, kill, do anything to get it.

The citizens of Texas are faced with a fight to prevent soil losses and save their water and grass resources from the host of undesirable woody plants that cover vast areas of the state. What is needed is a concerted effort on a wide front - information, education, research, legislation, financing, technical services, and operation on the land. Its goal should be control of water losses and increased grassland productivity that would assure the maximum benefits to landowners and downstream water users.

Texas simply cannot afford to waste their water resources.

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GRASSLAND RESTORATION and its effect on wildlife



Part VI of a Series

U.S. Department of Agriculture
Soil Conservation Service
Temple, Texas
September, 1970

The grasslands of Texas are a great renewable resource. They not only help make Texas the leading livestock producing state, but they also provide many other vital resources.

Grasslands are defined as lands on which the climax (natural potential) plant community is dominated by mixtures of grasses, grass-like plants, forbs and shrubs. They include not only the open prairies, but also the partially wooded savannas and wetlands suitable for grazing by livestock and wild animals.

Texas grasslands are the watersheds which provide most of the water used by our urban citizens, industry, irrigated agriculture, and for recreation. They are also home for a major part of the state's wildlife, and are the basis of much of our outdoor recreation.

We in the Soil Conservation Service believe there is a need for coordinated treatment and beneficial use of our state's grassland resources. Grassland improvement must be a package job giving full consideration to the needs of each of the multiple uses of these lands.

This series of GRASSLAND RESTORATION publications was initiated in 1964. Part I, The Texas Brush Problem, described the critical problem of brush invasion on grassland; Part II, Brush Control, dealt with methods of brush control; Part III, Re-establishing Forage Plants, was devoted to procedures for revegetating depleted land; Part IV, Grassland Management, outlined grazing management needs of grassland; and Part V, Effect on Water Yield and Supply, pointed out the vast loss of water through uneconomic woody plants and suggested ways for reclaiming much of this loss.

This publication, written by Vernon Hicks and Howard Passey, treats the important and valuable wildlife aspects of GRASSLAND RESTORATION.

Because wild animals are an integral part of our grasslands, both the animals and their habitat must be intelligently managed so they can provide for the increasing needs of all Texans.

We hope this publication points up some of the ways this can be accomplished.

We appreciate the assistance of the Wildlife Science Department and the Range Science Department of Texas A & M University; the Texas Agricultural Extension Service; and the Texas Parks and Wildlife Department for technically reviewing this publication and making suggestions for improvement. We also are grateful to the Texas Parks and Wildlife Department for the use of certain photographs.

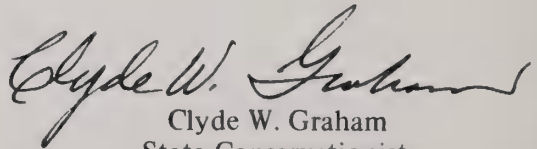

Clyde W. Graham
State Conservationist

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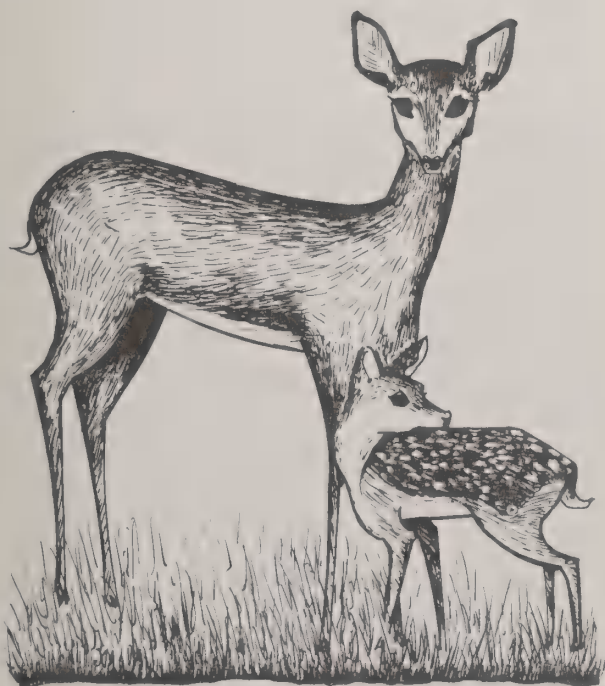
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Grassland Restoration and Wildlife



U.S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service, Box 648, Temple, Texas 76501



* GRASSLANDS

Texas grasslands are a valuable resource. The prairies, the wooded savannas, the wetlands suitable for grazing - these combine to make Texas the leading livestock state. They also form the watershed for most water used by cities and industry. And they provide a home for much of the state's wildlife.

* WHY DO GRASSLANDS NEED RESTORING?

Heavy grazing pressure and misuse has caused Texas grasslands to steadily deteriorate. As choice forage plants have been weakened and killed by overuse, they have been replaced with plants that provide less food for wildlife and livestock.

* HOW WIDESPREAD IS THIS PROBLEM?

A recent study revealed that 82 percent of Texas grasslands have been infested with unwanted woody plants. About 50 percent were found to be so dense that most moisture entering the soil is consumed by brush. These non-economic plants waste an estimated 38 percent of the state's total annual rainfall.

* HOW ARE GRASSLANDS RESTORED?

It takes a combination of treatment measures. This might mean controlling brush to reduce competition for moisture, range seeding, periodic rests from grazing, leaving adequate leaf growth on key plants. Fencing, water distribution or other measures may be needed for better grazing management. But using the right combination of practices wisely is vital

* HOW DOES THIS AFFECT WILDLIFE?

Properly planned grassland restoration can be done in such a way as to benefit wildlife and livestock. Improved, highly productive grasslands offer a more stable wildlife food supply. Depleted grasslands infested with solid brush offer plenty of cover but little food during stress periods such as drouths or severe winters.

* WHAT ABOUT BRUSH CONTROL?

Controlling brush is one of several measures that can be used to help improve grassland and wildlife habitat. But it must be used wisely and in harmony with other conservation measures.

* CAN BRUSH CONTROL HARM WILDLIFE HABITAT?

Yes, if it is poorly planned or if it is not followed by sound grassland management. It can also damage the land for livestock if not done properly. But wise brush control followed by good grassland management can greatly benefit wildlife.



Excessive shading and sapping of soil moisture by thick stands of cedar, mesquite, oak or other kinds of brush prevent growth of forbs, legumes and grasses which are good food plants for wildlife and livestock.



Nature had a way of putting trees and other browse plants on certain soils while leaving others open.



Solid blocks of wooded areas are improved for wildlife by creating openings. This increases growth of forbs, legumes, and other choice food plants.



Most game birds and animals are "edge" creatures; they exist in greatest numbers at the edge of wooded and open areas. They prefer to feed in the open where food plants are more plentiful and more nutritious, yet they want wooded areas nearby for escape cover. Clearing strips, blocks or patterns in dense brush increases the edge preferred by wildlife.

Opening up dense brush also improves hunting and makes it easier for sportsmen to harvest surplus game. This is an often overlooked but important factor in game management.



Brush can be controlled in strips to benefit wildlife and livestock. Wooded areas should also be left along rivers, creeks, resacas and other natural drainageways since these are preferred wildlife areas.



In hilly topography, strips should be contoured to the desired width. This blocks long distance viewing. Deer and other wildlife feed across such areas freely.



This rancher left prime stands of mature cedar undisturbed to provide habitat vital to the golden-cheeked warbler. Unuseful brush makes way for range plants. Many forms of wildlife benefit from such a plan.



Healthy wildlife, good range, plenty of food and hiding places - this happens only when grasslands are managed wisely. And only when livestock and wildlife are kept in balance with forage produced.

YOU CAN GET HELP

If you are planning grassland restoration work, be sure to consider wildlife, livestock, and other land uses before you start.

For further information, contact the Soil Conservation Service which works through your local soil and water conservation district. SCS is listed in the telephone directory under U. S. Government, Department of Agriculture, Soil Conservation Service.



GRASSLAND RESTORATION

PART VI

EFFECTS ON WILDLIFE

By

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Wildlife means many things to many people. To some it's a robin in the springtime, a bass splashing at sundown, or a squirrel barking in a creek bottom. To some, it's the thrill of the hunt - for deer, turkey, quail, dove. But to others, wildlife means money . . . because wildlife is a multi-million dollar business in Texas.

Nearly a million people, many from out-of-state, buy hunting licenses in Texas every year and even more buy fishing licenses. Add up everything these sportsmen spend in search of game and it comes to quite a figure - probably in excess of \$500 million.

A majority of wildlife are a product of our state's 118 million acres of grassland. But so are cattle, sheep, and goats. The livestock industry is one of our state's biggest businesses; according to a recent survey, livestock now on farms and ranches in Texas have a value of about \$2 billion.



Hunting and fishing is big business in Texas. Sportsmen spend millions of dollars annually on equipment, food, gasoline and other supplies in pursuit of game and fish.

Due to pressures from grazing, our once-lush grasslands have steadily deteriorated. As the choice forage plants have been weakened and killed by overuse, they have been replaced with plants that provide less food for our wildlife and livestock.

So here's the question: If our grasslands are restored to their former rich productivity, how will this affect our state's wildlife resources? Can the needs of both livestock and wildlife be considered and provided for in grassland restoration?

To start to answer that question, it might be in order to think back a hundred years or more into our state's wildlife history. Early Texas explorers often recorded the presence or absence of wild animals.

Development of our country since pioneer days has had varying effects on wildlife. Some species have decreased while some have vanished. Others have flourished.



These explorers mentioned deer, antelope, bison, javelina, wild turkeys, quail and waterfowl. Wild bison no longer roam our grasslands, but we still have most other kinds of wildlife. They have survived settlement, the plow, barbed-wire fences, competition with domestic livestock, the meat hunter, and even the modern recreation-seeking hunter.

Early accounts of wildlife populations show that many of these animals, including deer, lived in open grasslands, often at considerable distances from tree or brush cover. Some have speculated that these impressions were gained simply because the animals were easier to see in open country. There is ample evidence, however, that these were preferred grazing areas for wildlife. Food habit studies have shown that deer and antelope feed heavily on herbaceous legumes and forbs in grasslands, but utilize very little grass. In any event, part of the vast open grassland which was once used exclusively by game animals has succumbed to the plow and cultivated crops. Some is occupied by cities, industrial developments, and

highways. Wildlife has been pre-empted by domestic livestock on some land. With grazing misuse as well as control of periodic fires, much of the formerly open grassland has been invaded by a great variety of woody plants with a corresponding decrease in the original grassland forage plants.

Other areas originally supported thin stands of trees and shrubs, were dotted by motts of trees, or had irregular narrow strips of woody plants along stream courses. These lands also grew vast amounts of palatable and nutritious forbs and grasses which were used first by wildlife and later by domestic grazing animals. Relentless overgrazing and invasion by aggressive brush has changed these lands, too.



Deer and other forms of wildlife are found in greater numbers along the edge between wooded and open areas. Lush growth in the open provides an abundance of food while the woods offer protective cover.

Wildlife species which were able to adapt to changing conditions in their habitat prospered while less adaptable kinds declined. Some, such as the colorful pronghorn antelope, became almost extinct and have only recently become reestablished in appreciable numbers. In contrast, the white-tailed deer has not only adjusted to changed conditions but has thrived on the changes. Moderate grassland deterioration, in many instances, has actually improved the habitat for deer. Thick stands of tall grasses, which are not good deer food plants, were opened-up and replaced by legumes, forbs and other grasses which are choice deer foods. Brush invasion in formerly extensive open areas has provided browse type food plants and the necessary escape cover to support a good deer population.

These changes in habitat, control of natural predators, benevolent legislation, strict game laws, game law enforcement and the recent successes in control of the screw worm have

avored the increase of the white-tailed deer. They are now much more numerous in Texas than at any time during recorded history. In some parts of the state their numbers have increased to the point that overpopulation has become a primary problem.

Besides changes in habitat and other factors affecting wildlife, the role of these animals in relation to man has also undergone drastic change. Wild animals were a necessary and critical source of food and clothing for Indians. They helped sustain early explorers and supplemented the meager fare of struggling settlers. But the place of wildlife has now become one of supplying an expanding demand for recreation as well as a source of cash income for modern day "settlers." Although our many kinds of wildlife still furnish tons of food, their greatest value lies in the recreation they furnish.

Important and valuable as our wild animals are, they are still only a part of our grassland's vast complex of land, plants and animals. All uses and products of our lands must be provided for. We can ill afford to subvert one use to the exclusive benefit of another, or to destroy one resource to obtain temporary profit for another.

Most Texas grasslands are now producing considerably less forage, livestock, wildlife, recreation and clean water than their potential. They are badly in need of proper treatment and good management to provide for optimum returns to all grassland users.

Methods of brush control, revegetation, water salvage and forage management for livestock have been treated in previous issues of this series of publications. This part will be devoted primarily to the management and treatment of the grasslands in relation to wildlife and recreation needs. Because deer are perhaps the most important and valuable single kind of resident wildlife in Texas, their management and the treatment of their habitat will be featured but other important wildlife species will also be considered.



HABITAT REQUIREMENTS—FOOD AND COVER

The basic requirements for most wildlife species are year-round supply of food and water plus a safe place to hide, rest, roost, nest and raise young. Neither adequate cover nor adequate food alone provide all their needs. (The pronghorn antelope is an exception. He prefers wide open spaces where his remarkable eyesight and fleetness provide needed escape from his enemies.)

Deer Food – Deer are quite selective in their food habits but they forage on many different kinds of plants when available. All parts of some plants are eaten; only the fruits, leaves or tender twigs and shoots of others are taken. Some plants are relished during certain periods of the year but are hardly touched at other times. Other plants such as annual forbs (broadleaf herbaceous plants) are available only for short periods.

Although deer are thriving on some offshore islands along the Texas Gulf Coast where browse is almost totally lacking, these plants are an important item in the year-long diet of most deer. (Browse is defined as twigs, leaves and young shoots of shrubs and trees.) However, deer do not fare well on a diet entirely of browse, even though quality and availability may be good. They also require succulent forbs and grasses, especially in the spring and early summer when does are nursing fawns.

Not all woody plants are desirable forage. Many kinds of brush and trees are not eaten even though deer may be near starvation. Some of these plants do furnish cover, however.

Mast (fruits, acorns, nuts and seeds of trees and shrubs) are a welcome part of the deer's diet. In the Hill Country for example, acorns may make up most of the deer's food for a few weeks of the year. During good acorn years hunters harvest fat deer. But acorns and other kinds of mast are not always dependable sources of food.



Continuous heavy use by livestock and deer can kill such choice browse plants as vine ephedra. Nature then replaces them with less desirable plants.



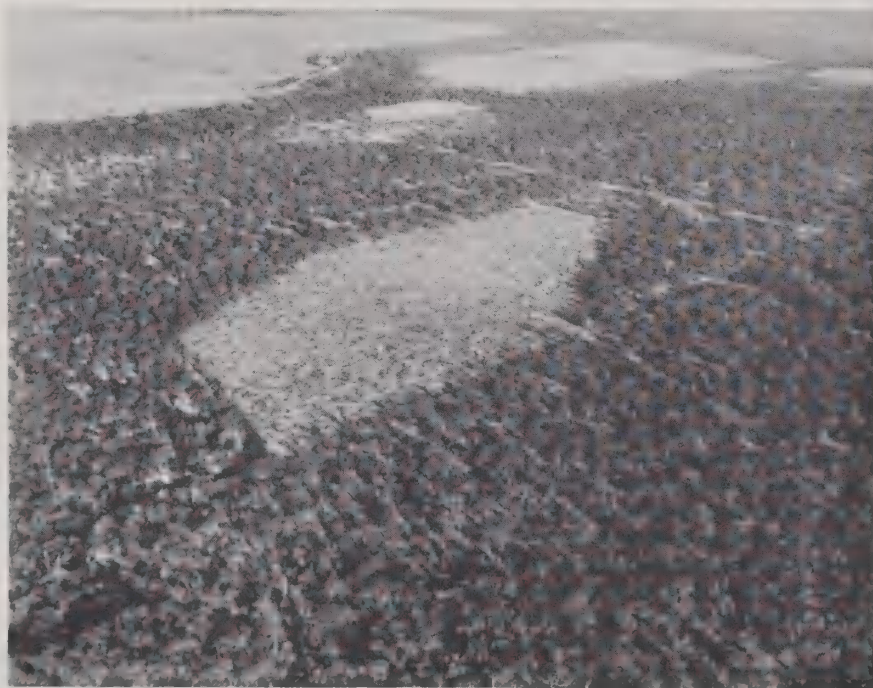
Small grain fields are used heavily by deer, turkey and other wildlife for green forage during fall and winter.

Deer are especially fond of some kinds of cultivated crops such as corn, alfalfa and cowpeas. Oat fields are very attractive to deer during late fall, winter and early spring when natural green forage is scarce. Many ranchers have planted small grains to provide winter grazing for livestock only to find that deer have moved in to help harvest their crop. Some landowners plant small grain crops especially for deer.

Deer Cover – Deer, like most other kinds of wildlife, require protective cover. They need a place to hide from their enemies. They prefer to remain in secluded areas during the day and then venture out into the open during the evening, at night and during early morning hours. They need a place to bed down in the shade during hot weather and out of the wind and cold during winter. In hilly country, as any good hunter knows, they seek shelter and cover on steep shaded slopes or in canyons or headers where it is difficult for man or other enemies to approach them. Does hide young fawns in dense cover until they are strong enough to follow their mothers. Tall grass or weed cover is especially attractive for hiding fawns. Deer also like secluded travel lanes where they can travel to and from water and feeding grounds without being seen.

Patches and strips of brush or trees, especially along the draws, creeks, bottomlands, canyons, and steep slopes furnish ideal cover as well as forage for deer. Deer often bed down in tall grass or weed cover or under rocky ledges. For the most part, however, trees and brush furnish the most desirable and available cover.

Despite their liking for woody cover, deer do not prefer vast expanses of unbroken woody areas. They are much more at home where there are frequent clearings and open areas interspersed with woody plants. They are sometimes referred to as edge animals because they do much of their foraging in the open but near the edge of brush and trees. These openings usually furnish more forbs and other succulent plants they prefer while the woody cover is nearby if they need to hide out quickly. Therefore, even though brush is most important to deer, too much brush just as too little brush, may be a disadvantage.



Solid blocks of wooded areas are improved for wildlife by creating openings. This increases production of forbs, legumes and other choice food plants.

Wild Turkeys – Turkeys eat an extremely wide variety of foods. Their fare varies seasonally and includes such things as green grass, insects, grass seeds, acorns and most any kind of wild fruits and nuts - including pecans. Grasshoppers are a favorite food. Turkeys do not hesitate to forage on remote croplands where they enjoy most kinds of forage and seed crops. Grass and weed seeds are usually the mainstay in their diet, especially during the winter after fruits, nuts, and acorns are gone. Turkeys are more far ranging than deer and will often travel many miles during the year in search of preferred kinds of food and suitable cover.



Turkey feed extensively in the open but must have wooded areas nearby for protective cover. During mid-day they loaf in groves or motts of brush.

Cover is extremely important to turkeys. They are naturally shy and, although they are often seen in open fields or crossing highways and even occasionally near farmsteads, they spend most of their time in wooded or brushy areas. Turkeys also are particular about roosting sites. They like tall trees with widely spreading branches or dead limbs, preferably surrounded by underbrush. Such trees along streambottoms are most commonly used. Turkeys may use the same roost night after night, or may have several roosting areas which they visit periodically. Without adequate roost trees, turkeys will not stay in an area even if food is abundant. Turkeys are also very selective in choosing nest locations. They like to hide their nest in thick cover but not too far from food and water so they will not need to leave their nests for long periods during incubation.

Turkey nesting sites are usually hidden near brush piles or other good grass areas. Poor cover on overgrazed ranges limits nesting and turkey reproduction.



Heavily grazed lands are poor turkey ranges. Unless reasonable amounts of grasses are permitted to go to seed, there will be little dependable turkey feed or nesting cover. Likewise, excessively cleared lands do not supply the needed cover for these fine birds.

Quail — Quail, too, use a wide variety of foods during the year. In their first few weeks of life, quail chicks feed almost entirely on small insects and larvae. Adult quail also feed heavily on insects during the spring and summer. They also enjoy a wide variety of fruits and succulent plants. But as fall approaches, the insect life and fruit supply diminish and quail become primarily seed eaters. They consume large quantities of weed seed, nuts such as acorns, and seed of certain kinds of grasses and shrubs. Some of the introduced range grasses such as blue panicum and kleingrass produce large volumes of seed for quail.

Quail prefer a mixture of wooded and open areas with small motts of low shrubs or vines. They need seed producing plants such as weeds, legumes and annual grasses for food and good grass areas for nesting sites. Quail will not travel far between food and cover.



Because of their preference for weed seeds during much of the year, quail are often found along the margins of cropland fields, on overused weedy grasslands and on areas where soil disturbance results in good growth of weeds and forbs. Grassland in excellent condition or dense brushy areas are not good producers of quail feed. Many landowners disk or plow strips of land near good quail cover to promote weed growth for the birds. Others feed harvested grain to sustain their quail when natural food is scarce. Many farmsteads are brightened by a covey or two of these interesting birds which are kept tame by daily handouts of feed.

Even though they do much of their feeding in open areas, quail need protective cover nearby where they can readily seek shelter when disturbed. They rest in the shade of trees and shrubs during warm summer days and seek thick cover for shelter from storms or cold weather. Nests are concealed at the base of grass plants or other protective vegetation. Roosting sites are on open bare ground or in short grass areas where there are no obstructions to sudden flight to escape predators.

Pronghorns (Antelope) – The pronghorn antelope, now confined mostly to the High Plains and Trans-Pecos areas of the state, are primarily forb, weed, and browse eaters. They also eat a variety of grasses throughout the year, but grass is a minor part of their diet. They readily consume a number of small brushy plants such as perennial broomweed which are not considered as forage for livestock. They eat several forbs, including paperflower and groundsel, which are poisonous to livestock but which do not seem to affect the pronghorn. Since food habits are quite similar to those for domestic sheep, they often suffer from competition with these animals. Pronghorns do much better when only cattle are using the range because of less competition for preferred plants.



The pronghorn antelope is one of the few game animals which neither needs nor wants much cover for hiding or resting. They prefer to remain in the open where enemies cannot approach without being seen.

Unlike deer, pronghorns rarely jump over standard livestock-proof fences. They readily crawl under or pass between the strands on barbed-wire fences, but woven or net fences used to control sheep present a serious barrier to their movements. Pronghorns sometimes starve on overused pastures simply because they are reluctant to cross a sheep-proof fence and move to pastures with adequate forage. Ranchers in pronghorn country should leave gates open or let down segments of their fences when there are no livestock in the pastures. This permits pronghorns to move from pasture to pasture in search of forage. New types of fences have also been developed which will control sheep and cattle but can be negotiated by pronghorns. The agile pronghorn will also jump over cattle-guards if they are located in the fence corners or other natural crossing places.

Javelina – The unique javelina (also known as the collared peccary) is an interesting little animal somewhat resembling the wild hog. They have long been considered a nuisance on ranchlands but are rapidly coming into their own as game animals. More and more hunters are turning to the challenge of stalking the javelina. It is becoming a favorite of the bow hunter.

It has been said that the javelina will eat anything he can catch, reach or dig. This is almost true. He enjoys a wide variety of food items ranging from pricklypear cactus to snakes and rodents. He is especially fond of fruits, acorns and nuts and will eat some succulent forbs and grasses. Cactus and lechuguilla, plus fleshy roots, bulbs and tubers are probably the main items of the year-round diet.

The javelina is at home in rough, steep, rocky semi-desert lands but also thrives in more humid and level brush country. Thick brush and cactus patches make fine javelina cover.



Other Animals – Many other types of wildlife play a vital role in nature's way of maintaining a balance of animals and plants. The ecological role of many predatory animals, furbearers and others are not understood by most people; therefore they do not consider them important. Nevertheless, these animals are essential in nature's scheme of maintaining a fluctuating balance of one kind of animal in relation to another; or certain animals, such as the rodent group, in proportion to vegetation produced.

Habitat preservation and management for some of these important, yet less publicized, types of wildlife should be part of any grassland restoration program. Sufficient trees and underbrush should be retained along waterways and bottomlands to provide protective cover, den sites and fruit and berry production necessary for survival of these animals.

Doves – The mourning dove furnishes a great deal of hunting pleasure in Texas. We have resident doves which nest within the state and transient birds which nest in more northern states, then migrate to Texas in late summer and early fall.

Mourning doves usually are associated with cropland because of their liking for weed seeds and grain. They are also found along roadsides and in weedy rangeland pastures where they can find their preferred foods. They often depend on rangeland water holes and troughs for water. Their twice-daily excursions to water provide excellent wingshooting for hunters. Mourning doves use trees and brushy areas for cover and roosting but do not need great amounts of brush. They prefer to nest in trees and shrubs but sometimes make a simple nest on the ground in a sheltered place.



A relatively small but ardent group of sportsmen are those who enjoy a good raccoon hunt, fox chase or listening to hounds run a coyote all night. Habitat for this type wildlife should be maintained also.



Dove feed on seed of many grasses, weeds and legumes found growing in and around cropland and on native grasslands. Woody areas are important for roosting and nesting sites.

The white-winged dove is a sub-tropical game bird. About 95% of all white-winged dove raised in Texas are produced in Cameron, Hidalgo, Willacy and Starr Counties. The other 5% are produced along watercourses and in townsites in San Patricio, Bee, Bexar and Uvalde Counties and along the Rio Grande to El Paso. These birds all return to Southern Mexico and Central America in late summer. They tend to nest in large colonies, but only in trees and large thorny shrubs with very dense foliage. Although many nest in citrus groves, they depend heavily on native vegetation for nesting sites as citrus groves are periodically reduced by freezing temperatures.

Prime nesting habitat consists of very dense jungle-type canopy of trees and underbrush. At present only isolated areas of choice nesting areas totaling less than 5,000 acres remain in the four main white-winged dove producing counties. These prime areas may have concentrations of several hundred pairs of nesting white-wing doves per acre. Adjacent land, without the dense canopy may have from 0 to 20 pairs per acre. Therefore, any tree or brush clearing in these limited prime nesting areas would be most detrimental.

Song Birds – Texas has more kinds of birds than any other state. Their food habits and cover requirements vary widely. Some are strictly insect eaters while others feed primarily on seeds and fruits. Some species live on open plains and prairies while others require some sort of tree or brush cover for nesting and roosting. Brushy areas near water are a favored habitat for many.

Fish – Fish are indirectly associated with grasslands. Since most water that flows into streams, ponds and lakes comes from grasslands, the quality of this water is dependent upon the condition of the plant cover. A good grass cover yields clean water, but depleted grasslands contribute mud, silt and debris. This lowers the quality of water for fish production and often destroys lakes and ponds by filling them with sediment. Controlling excessive stands of brush and replacing it with grass has increased the flow of many seeps and springs and has renewed the flow of many long-dry creeks.

There are thousands of ponds and small lakes on Texas grasslands which furnish untold hours of fishing enjoyment as well as income to the landowner. How well these fishing resources are maintained depends in part on how well the grasslands are treated and managed.



Runoff water from land with a poor grass cover fills farm ponds, lakes and stream channels with mud and destroys fish habitat. More than 6 feet of sediment was deposited in this pond in less than 8 years.

PLANNING THE USE OF FORAGE

Most Texas grasslands are used for domestic livestock production as well as for wildlife. Only a few areas are grazed exclusively by wild animals. Wildlife alone seldom make the most efficient use of grassland ranges. Optimum returns most often result from combinations of wildlife and domestic animals.

Even on well managed grasslands which support a wide variety of forage plants, there is competition between deer and domestic livestock for certain kinds of plants. Deer compete with goats for many browse plants and for mast. They compete with sheep for forbs and succulent grasses. There is less competition between deer and cattle because of wider differences in their preferred forages. Competition between deer and livestock for grass is usually critical only when grass is succulent and is limited in amount.

As the degree of forage utilization increases, competition becomes more keen as each kind of grazing animal is forced to consume plants which are normally less attractive. In conditions of severe overstocking, competition among all grazing animals for the same forage plants is almost complete.

Although deer use a large number of plant species, a relatively few species make up most of the diet on many kinds of grasslands. If these key plants are destroyed or reduced below the needs of the deer, the animals will not thrive even though other kinds of plants may still be available. This is why some rangelands support very few deer even though they appear to have ample plant cover.

When competition for forage is severe, deer nearly always lose out. Goats and sheep are much more adaptable to changes in forage. Goats prefer a diet containing large amounts of woody plants, but do quite well on grass as their major forage. Sheep, likewise, can subsist on grasses even though they prefer forbs and browse in addition to grasses. Ranchers provide supplementary feed for livestock when forage is short, but for deer, starvation is the usual consequence.

As with ornamental shrubs, a moderate amount of pruning (browsing) actually stimulates the growth of new twigs and leaves on many good browse plants. Heavy use, however, will seriously stunt or kill these plants. Severely browsed large shrubs and trees develop a browse line aspect where the upper portions may be vigorously growing but few shoots and little foliage is produced within reach of animals. When such a browse line is obvious, there is little forage available for browsing animals. Also, perhaps of greater importance, when palatable plants are heavily used by either deer or livestock, it means that seedling and young plants have been destroyed or seriously damaged. If the better plants are not permitted to reproduce, the species may be lost.

High quality browse plants are essential to good deer range. When the preferred food plants of small weeds, legumes and some grasses are not available due to drought, cold temperatures, etc., browse plants, such as mountain mahogany shown here, must supply the bulk of the diet.



Heavy browsing pressure by livestock and deer causes a definite browse line in wooded areas. All leaves are eaten from the lower limbs of the trees. Low growing vines, bushes and tree sprouts are kept continuously stripped. This eliminates the reserve food supply and causes severe die-offs in deer during dry periods when forbs and grasses are not growing.



Most of our grasslands are privately owned. The landowner or ranch operator must decide upon his own objectives for the use and management of his lands. One of the most important decisions he must make concerns the kinds and numbers of grazing animals to be stocked on his grassland range. This decision should be made only after careful

consideration of several factors. Professional conservationists from the Soil Conservation Service help land users analyze their grazing resources, considering such things as:

1. The kinds, amounts and seasonal availability of forage plants and the suitability of cover for wildlife;
2. The present forage production and the potential production which the lands are capable of supporting;
3. The forage preferences and requirements of various kinds of domestic animals and wildlife;
4. The probable amount of seasonal and year-long competition for forage plants by different kinds of animals;
5. Topography and accessibility of the grassland to different kinds of animals;
6. The economics of production of livestock as compared with that for wildlife; and
7. The personal desires of the landowner.

After considering these and other factors, the landowner or operator must balance the numbers and kinds of grazing animals with the available forage, plan his grazing management practices, and decide on the kind and amount of treatment his lands need to achieve his long-time objective.

If the landowner decides that deer production will be his primary objective, for example, he must stock his lands with only the number and kinds of livestock which will be compatible with sustained high rates of deer production. This usually means limiting the numbers of goats and sheep in order to leave plenty of the preferred kinds of browse and forbs for the deer. If, on the other hand, the landowner desires to produce the maximum numbers of goats, sheep or cattle, he must be content to produce less deer.

Regardless of the kinds of animals using the grasslands, their numbers must be carefully controlled to permit the key forage plants to remain vigorous and productive and to permit deteriorated grasslands to improve in condition.

The landowner should know the key forage plants and key grazing areas on his lands as well as cover requirements for wildlife. Armed with this knowledge, he can evaluate changes in forage supplies and can adjust numbers and kinds of animals to these changes.

The amount of forage produced per acre on any grassland is never constant. There are always good years and poor years for forage growth. Therefore, the progressive landowner follows a flexible stocking rate where animal numbers are reduced during poor years to avoid injury to the forage plants and increased in good seasons to take advantage of the additional forage available. Wildlife numbers, too, should be maintained in relation to the amount and quality of forage and cover available, with heavier harvests being made during years of poor plant growth.



To the outdoorsman there is no prettier sight than healthy deer on good range with plenty of feed and hiding places. This happens only when landowners keep livestock and deer in balance with forage produced.

Overstocked, heavily grazed ranges produce poor crops of game. Wildlife suffers first from abuse of the grasslands since they are less adaptable than livestock to low quality food plants.

Grazing Systems – In the past, most Texas grasslands were grazed year-long by livestock as well as by wildlife. Continuous grazing destroys many of the choice forage plants essential to wildlife and livestock production.

Forage plants are more vigorous and productive and they reproduce in greater abundance when given occasional rest from grazing during their growth periods.

Many landowners have begun to divide their grassland ranges into several fenced pastures and to adopt systems which provide periodic rest from livestock grazing for each pasture. Soil and water conservation districts, professional range conservationists, agricultural experiment station researchers, wildlife biologists, extension service workers, and others encourage wider use of these grazing techniques. Under such systems (referred to as rotation-deferred or rest-rotation systems), one or more pastures are rested while the remainder are being grazed. By rotating the rest periods, each pasture, in turn, has the benefit of a temporary rest from livestock.

Wildlife, especially deer, tend to concentrate in the pastures being rested. This permits them to graze without livestock competition for the choice forbs and browse during the rest period.

Pastures managed under such grazing systems have consistently produced greater sustained net returns from both livestock and wildlife than similar pastures grazed continuously at the same rate of stocking. The systems also permit an increase in forage production and encourage desirable changes in the kinds of forage plants. Grazing systems must be carefully designed to fit the specific resources and needs of individual grassland ranges.

HABITAT MANIPULATION

In their present condition, most Texas grasslands are not providing the best kinds and amount of forage and cover for either livestock or most kinds of wildlife. Proper grazing management is essential to efficient grassland production, but vast acreages need additional treatment for habitat improvement to meet the needs of all the uses of these lands. Within the limits dictated by soil and climate, there are usually many opportunities for beneficial and profitable manipulation of animal habitats.

Control of Woody Plants – Some 88 million acres of Texas grasslands are now covered with one or more kinds of brush. This infestation has been occurring since the Civil War. On fully half this acreage, excessive brush seriously limits forage production for livestock as well as for wildlife. Most kinds of woody plants are water wasters. It takes several times as much water to grow a pound of brush as it does to grow a pound of good, nutritious grass or forbs. Many woody plants are very aggressive and dominate the plant community for limited moisture, sunlight and plant nutrients.

Some shade-loving forbs and grasses will grow under a thick stand of brush. But many of these plants are much less palatable and nutritious than those which grow in full sunlight so both deer and livestock tend to pass them up. Besides, animals cannot get to forage plants hidden in brush thickets or cactus patches. So, even though there may be a moderate amount of vegetation on very brushy ranges, it is not necessarily all palatable, nutritious nor available to animals. A few shade-tolerant plants such as the sedges (grasslike plants) do provide good forage, especially during winter months. But even these plants are not available to animals if the brush is too thick.

Livestockmen simply cannot afford to produce uneconomic plants on their lands. To stay in business, they must make their lands produce usable and profitable forage. For this reason, several million acres of brush-infested grasslands are treated mechanically or chemically each year to control unwanted woody plants and to restore higher levels of forage production. Indiscriminate brush control, however, without regard to wildlife needs destroys many woody plants valuable for forage and wildlife cover.

As already stated, the right amount of brush - but not too much - is essential and desirable for wildlife food and cover. When both livestock and wildlife use grassland, it often becomes necessary to compromise between the needs of both kinds of animals when planning brush control measures. The ideal compromise is to control enough brush to significantly increase forage production for livestock but to leave enough browse and cover for wildlife.

Excellent cover but no feed! Excessive shading and sapping of soil moisture by thick stands of cedar, mesquite, oak or other kinds of brush prevent growth of weeds, legumes and grasses which are good food plants for wildlife and livestock.



Nature had a way of putting trees and other browse plants on certain soils while maintaining other soils as open grasslands. The resulting combination was lots of edge and excellent wildlife habitat. On many grasslands, overgrazing has killed the dominant grasses and brush has encroached over the entire area.

Thick stands of brush can be opened up to resemble somewhat a pattern mother nature once had. The deep productive soils can be used to grow grass, legumes and weeds which make up most of the forage used (poundage wise) by livestock and wildlife. Thin, steep, rocky or other unproductive areas should be left in brush and trees for browse and cover for wildlife.



The amount of woody plant cover needed to sustain desired wildlife populations varies with the kind and quality of the cover, topography, soils and the grazing needs of both livestock and wildlife. High populations of deer and other important wild animals can usually be maintained and adequate grass produced for livestock when 25 to 35 percent of the land is left in brush cover, if the brush is properly arranged to benefit wildlife.

Brush Control Patterns – For optimum production of both wildlife and livestock, brush should be controlled in strips or blocks alternating with untreated areas. Brush should always be left along drainageways, on steep slopes, near watering and roosting places, and on other areas most attractive to wildlife. Clearing brush in such patterns greatly increases the edge (brush-grass edge areas) available to wild animals. Deer populations on brushy grasslands treated in this manner have a much better balance of food and cover plants than where entire pastures are either left in thick brush or are entirely cleared of woody plants.



Landowners should give close supervision in brush control operations to see that contractors carry-out the planned pattern of brush control. By doing this, the correct amount of brush can be maintained in the exact places desired.



Contour strips can be opened in hilly topography to the width desired for increased forage production. Long distance viewing is blocked by the curvature of the opening. Deer and other wildlife feel perfectly safe to feed into and across these openings.

Before planning brush control patterns, the kinds and location of woody plants in the pasture should be evaluated. The best kinds of browse plants are often found along drainageways, on rocky hillsides or on gravelly soils. These areas should be left for wildlife and those parts of the pasture with fewer desirable browse plants should be included in the cleared strips.

The proper width of strips to be left in brush varies with the kind of woody plants, their height, density, and topography. If brush is short, or very tall with little cover near the ground, brush strips should be wide. Narrower strips of brush are more suitable when brush is dense than when it is in an open stand. Flat country usually needs wider brush strips than hilly or rolling country. Strips should be wide enough to include adequate amount of needed browse and to permit wildlife to hide from view easily. As a rule of thumb, brush strips should never be less than 300 feet in width, and cleared strips should not be more than 1,000 feet.

Broken strips offer greater hunter safety and some think deer move across short openings more freely. Deer and other wildlife continue to use grassland with any type of pattern so long as sufficient brush cover is maintained. The landowner must decide which type of pattern will best fit into his livestock and wildlife operation.



In flat country, strips can be opened in any pattern desired. Many ranchers use straight strips while others use a zig-zag or similar pattern to block long distance viewing.



Brush should be left along rivers, creeks, resacas, playas and other natural drainage ways which are preferred game areas. Turkey roosts and potential roosting sites should be located and preserved.

Besides increasing the amount of edge, patterned brush control has other benefits to wildlife management. Game animals are more easily seen because of the clearings created. They are easier to hunt, too, and many sportsmen will pay premium lease rates to hunt on such land. And, extremely important in management, it is much easier to obtain an adequate harvest of game on lands treated this way.

Brush Thinning -- Wildlife habitat can be improved in some brushy pastures by thinning the stand of brush rather than by strip or pattern control. By use of an axe, bulldozer or other means, undesirable trees and brush can be controlled without disturbing the desirable browse plants. Such thinning lets more sunlight reach low-growing plants and increases the value of the pasture for wildlife as well as livestock. This kind of treatment is often more expensive than strip or pattern clearing because it requires more hand labor.

Thinning is appropriate on many areas where juniper (cedar) or mesquite has invaded stands of more useful woody plants such as live oak. Juniper, in controlled amounts, is desirable for bird nesting areas and for cover and emergency food for deer, but many areas have far too much for any useful purpose.

Brush Manipulation -- Several kinds of trees and shrubs such as live oak develop a high browse line when overused by goats or deer and produce little usable forage. Some of these plants are root sprouters. When their tops are removed, sprouts grow from near the base of the plant. It is often practical to stimulate basal sprouting by removing the tops by chaining, chopping or bulldozing. Browse plants treated in this manner, however, need a rest from heavy grazing until new sprouts have made considerable growth. Even after such treatment, grazing must be carefully controlled to avoid killing the sprouts or creating a high browse line again.



Overbrowsed ranges can usually be restored by initiating a rotation grazing or deferred grazing program. Some species do not respond as readily as live oak and may need top growth removal by shredding, chaining or some other means to stimulate root or basal sprouting and produce forage within reach of the animals.

Shin oak, some of the acacias such as catclaw and blackbrush, and several other good browse plants can often be profitably mowed or shredded to promote growth of tender shoots which are much better forage than the coarser growth of untreated plants. Some landowners shred such stands of brush every three or four years to maintain adequate amounts of choice forage for their deer and livestock. Shredding or mowing also temporarily increases the amount of forbs and grasses and makes the treated area more accessible for grazing and hunting.

Other Considerations – While planning habitat manipulation, the landowner should give careful consideration to leaving sufficient desirable trees and shrubs to maintain the beauty and esthetic values of his property. The demand for rural homesites is growing rapidly. Attractive trees and well spaced shrubs often add materially to the value of land for such purposes. Other forms of outdoor recreation, such as camping, picnicking and bird-watching are enhanced by attractive natural surroundings.

Adequate nesting sites should always be left for song birds. Presence of these birds is beneficial to the landowner and a source of pleasure for outdoor recreationists.

If there is any question whether trees should be left or removed, it is best to leave them alone until it is certain there is no need for them.

Habitat for quail, cottontail rabbits and other small animals can be improved by piling or stacking brush removed from treated areas. Brush piles, though temporary in longevity, are ideal cover. Many landowners have greatly increased the number of quail and other animals on cleared pastures by this means.

Landowners should recognize areas with natural features which make them attractive for rural homesites, vacation cottages, or recreation areas. Such land is much more valuable if left in trees.





Landowners should consider all wild-life habitat needs in planning a brush control program. Here SCS District Conservationist Frank Sprague and rancher John Camp, plan a brush control pattern near Kerrville.

Camp selected a pattern which would open up the better soils to increase forage for livestock and deer, while leaving cedar and oak for the rare Golden-cheeked warbler. The warbler uses only mature cedar for nesting. This pattern also provides excellent cover and feeding areas for other wildlife such as deer and turkey.



Revegetation — Some grasslands are in need of revegetation - either with or without brush control. Severely depleted plant cover can sometimes be profitably restored through seeding adapted plants. Likewise, undesirable plant cover can be cleared and replaced by more useful kinds of plants.

Seeding grasses on depleted or cleared grasslands has become a common practice, but little work has been done on establishing plants especially for wildlife. At the Soil Conservation Service plant materials center near Knox City, collections of many kinds of useful shrubs and forbs are being tested for wildlife plantings. This effort will be accelerated.

Water — In addition to food and cover, wild animals also need access to good quality drinking water. Many grasslands used for livestock grazing have adequate watering facilities which wildlife can use. Stockwater ponds with gently sloping banks enable all kinds of wildlife to reach the water safely. On some ranches, however, water is supplied to livestock in straight-sided troughs which may be too high for small animals to reach. These troughs can often be made more useful to wildlife by installing ramps both outside and inside so small animals can get to the water. Ramps inside troughs and storage tanks also enable birds and small mammals to escape when they accidentally fall into the water.



Native browse and grazing plants on cartoonist's Ace Reid's ranch near Kerrville made fast recovery following brush control on re-growth cedar and rest. Note trees left for wildlife.



Some grasslands are so badly deteriorated that a seed source of desirable food plants is no longer available. Such land needs brush control and seeding. SCS is trying to develop better ways to establish choice browse and other food plants on this type land.

Water is poorly distributed on portions of some ranches in the hilly and mountainous parts of the state, and areas of choice wildlife habitat cannot be used because of the lack of water. Small catchment basins, ponds or other watering devices can sometimes be installed at reasonable cost to permit wildlife to use these remote areas. Such installations may not store enough water for livestock use, but will provide for significant numbers of wild animals.



Alterations are needed on some livestock watering facilities to get water in reach of wildlife. Several ground level modifications have been devised.

HARVESTING GAME ANIMALS

Game birds and animals are part of the crop produced on grasslands. Like any other crop, it should be harvested. Any habitat has its limits in the amount and quality of food and cover it furnishes and the number of animals it can support without deterioration. Whether it be domestic livestock or game animals, their numbers must be kept safely within the limits of their environment. If too many animals occupy an area, they will not thrive and sooner or later the surplus animals will die of starvation or from disease or parasites triggered by malnutrition.

As every experienced ranchman knows, he cannot continually keep all the calves, lambs and kids produced on his lands. If he did he would quickly run out of feed and space to support them. He can feed extra animals out of a sack for a while, but soon has to balance his herd with his forage supply. The same limitations apply to wildlife. Surplus animals must be removed to prevent misuse of grasslands and to maintain a thriving herd.

Underharvesting of deer is a critical problem in many parts of Texas. Deer have a high reproductive potential. Herds on suitable ranges with adequate forage and cover may increase at rates of 25 to 40 percent or more each year. Except on ranges now stocked below their capacity, at least one-fourth of the total deer numbers must be removed each year to prevent overpopulation. But in recent years, only about 10 percent of our deer herd has been harvested annually. As a result, many deer ranges are too heavily stocked; many animals die of starvation or disease; surviving deer are small in size, and perhaps most serious of all, the forage plants on which they depend are seriously damaged.



Healthy deer herds cannot be maintained long by feeding from a sack. Deer must have nutritious native vegetation for the bulk of their diet.



Well managed grasslands produce healthy deer herds. When livestock and game animals are balanced with the food supply, a good fawn crop is weaned annually and a good harvest can be expected each year.



Stunted animals, poor or deformed antler growth and other deformities are the results of a restricted food supply from time of birth on overpopulated deer ranges. (Photo courtesy of Texas Parks & Wildlife Department)

Most modern sportsmen are trophy hunters. They seek the bucks with the largest antlers and frown upon shooting does. But harvesting only the males does not slow down reproduction or lower the population because deer are polygamous. This traditional reluctance to harvest females was appropriate many years ago when deer numbers were few, but it has continued long after its need ceased to exist.

The same hunter who will not kill doe deer will not hesitate to shoot female quail or doves nor to catch female fish. He also knows that if ponds are not fished heavily enough the fish do not make good growth because there are too many for the food supply. He often does not realize that the same is true with deer and other wild animals. Females as well as males must be harvested if deer numbers are to be kept in balance with available forage. Starvation and forage plant depletion are the inevitable results of inadequate harvesting.

Some landowners have the mistaken belief that all doe deer must be protected in order to produce enough bucks for hunters to harvest. The fact is, however, that when too many does are on the range they do not reproduce successfully. Many does on overcrowded grasslands either fail to produce fawns or lose their fawns before weaning time. A hundred does will wean more fawns where food and cover are adequate than will twice that number on overstocked lands. Thus, more young bucks will be produced each year on properly managed range than on similar range which is carrying too many deer.

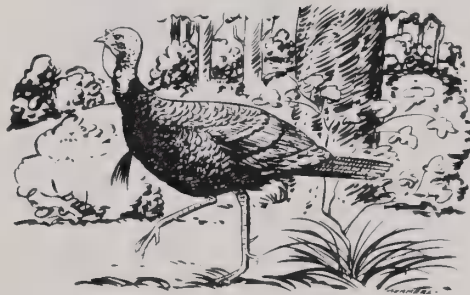
Deer and other kinds of wildlife cannot be stockpiled. If surplus animals are not harvested by hunters, they will die of other causes. And it is the young animals which die first - including the buck fawns which would have been trophies in another year or two. We are not being kind to wild animals by refusing to harvest them - we are merely consigning many of them to a slower, more agonizing natural death. Wildlife which starve on overstocked ranges are an economic loss to the landowner as well as a recreational loss to the sportsman. Yet more deer are lost through natural causes than are taken by all sportsmen on Texas grasslands. We cannot afford such waste.

Within the limits of state and county regulations governing wildlife, landowners usually have a number of ways to help their hunters make an adequate harvest of wildlife. When brushy lands are cleared in patterns, as previously discussed, game animals are easier to see and to bag. Food plots such as small patches of oats or other cool season crops will attract animals and make them easy to harvest. Stands, blinds or platforms in trees where hunters can hide at strategic locations are often helpful.

Some landowners require hunters to include at least one doe deer in their bag limit. Others charge much less for hunting does than for bucks, or give the hunter an extra doe permit as a bonus. Some ranches are leased for buck hunting during the first part of the hunting season and for does during the latter part - often to different hunters. Still other ranches are open to day hunting for does only. The landowner who fails to get adequate wildlife harvest not only loses potential income, but also faces problems of overstocked lands. Overharvest of deer is seldom a problem in most of the state. But, if a landowner finds he has harvested too many females, he merely has to limit hunting to bucks only for a year or two and deer numbers will quickly increase.

Sportsmen, too, can help with proper management of wildlife. They must overcome prejudice and outmoded tradition against harvesting females in order to insure a sustained production of wildlife for the future.

Overpopulation is not now a problem with many other kinds of wildlife. Carefully controlled cropping of surplus animals is still in order for pronghorn antelope, wild turkeys, and other less numerous kinds of wild game.





Most hunters, like this group on the Fred Coleman Ranch near Junction, seek trophy type game; however antlerless deer must also be harvested in most areas to hold the deer herd in balance with forage.

The deer herd should be reduced each hunting season to the level of the food supply so remaining deer will have plenty of winter feed and drop a good fawn crop. This will keep a good buck crop growing off and prevent the deer herd from becoming stagnated with barren does.



Several ranchers sponsor this annual doe hunt for children of an orphan's home. This teaches the youngsters how to hunt and to be good sportsmen, reduces the deer population, and furnishes badly needed meat to the orphans home.



Businessmen and civic organizations should be just as concerned with the condition of wildlife habitat in an area as the landowners or sportsmen. Hunting brings millions of dollars to merchants in rural communities from other parts of the state.

ECONOMIC CONSIDERATIONS

Wildlife can provide an important source of income to landowners. Increasing numbers of sportsmen are willing to pay attractive sums for hunting on privately owned lands.

All native game birds and animals in Texas are the property of the state, and their harvest, by hunting or by any other method, must comply with state-enforced regulations. Rights of private property ownership are also respected by law, so the landowner controls trespass upon his lands. Landowners cannot legally sell game animals but may collect fees for hunting on their lands.

Over 50 million acres of Texas grasslands are used for recreational hunting. Each year more than 15,000 landowners make their lands available for hunting on a fee basis. Sportsmen spend millions annually for hunting; direct and indirect income from hunting is second only to that from domestic livestock in many rural areas of the state. So, wildlife and wildlife-based recreation are big business in Texas. Not only do landowners benefit from wildlife, but so do the businessmen who furnish food, clothing, lodging, hunting equipment and automobile supplies to the sportsmen.

Hunting privileges on many farms and ranches are reserved for family, friends or business associates. But, whether leased for cash or reserved for private use, lands supporting healthy wildlife are of great value to the owner. A number of studies made by the Soil Conservation Service show that net income from hunting equals or exceeds that from livestock on many ranches. Income per animal unit of deer (an animal-unit is the equivalent of one cow, five sheep, or 6 deer or goats) compares very favorably with that from livestock if the deer herd is properly managed and harvested. Income from hunting quail and doves ranks closely behind that from deer. Net annual return of \$1 or more per acre from wildlife are very common.

EXOTIC GAME ANIMALS

A relatively recent but rapidly expanding use of grasslands is for the production of imported kinds of game animals. Commonly known as exotics, these fine animals represent another potentially profitable enterprise.

Exotics were first introduced into Texas about 1930. Several additional introductions have been made since. Although more than a dozen species have been introduced, the most popular kinds are blackbuck antelope, axis deer, fallow deer, sika deer, mouflon sheep and aoudad sheep.

With the exception of aoudad sheep in Palo Duro Canyon, exotic game animals are not under state game law regulations. Several imported species are suitable for hunting at most any time of the year. A few ranches are devoted primarily or exclusively to the production of exotics in addition to the native white-tailed deer. It has been estimated that there are now over 35,000 exotic game animals in Texas. For a fee, sportsmen can collect one of these magnificent trophies a short distance from home without having to make a long trip to a distant land where the species is native.

A trial introduction of aoudad sheep into Palo Duro Canyon by the Texas Parks and Wildlife Department in the winter of 1957-58 has been highly successful. These splendid but shy animals, well adapted to rough and rugged terrain, have increased from the original 44 animals to an estimated population of over 600. Limited public hunting since 1963 has provided a real challenge to Texas sportsmen and another source of income to landowners in the vicinity of Palo Duro Canyon.

Although exotic game animals are meeting with apparent success with sportsmen and landowners alike, considerable study and observation remain to be made to plan proper management for these animals. Relatively little is known of food and cover requirements of most exotics, their compatibility with native game species, or the extent to which they may compete with domestic livestock for forage plants.



Many species of exotic game animals, such as the Impala shown here have been stocked on private lands for trophy hunting. Several foreign species of antelope, deer and sheep apparently thrive on Texas grasslands.



Long term effects of exotic game on native deer, domestic livestock or deer habitat are unknown. Most exotics appear to compete more with domestic animals for the same plants than with deer. As with other grazing animals, their food habits will have to be determined and numbers kept in balance with forage.

CONCLUSION

The successful integration of wildlife, livestock production, recreation, water supply and the many other uses of our grassland require careful and competent planning. It also requires the full cooperation of landowners, sportsmen, businessmen, conservation agencies and groups, and even urban residents who depend on the grasslands to fulfill their particular needs. Multiple use of resources can be a complicated undertaking. But the opportunities are many and the potential returns are significant.

In each county in Texas the Soil Conservation Service has professional conservationists who work with landowners and others in helping plan and apply sound programs for conserving, developing and using natural resources. If you need their help, they will welcome the opportunity to assist you. This work is done through locally organized and locally run soil and water conservation districts.

The Texas Parks and Wildlife Department also has a field staff of biologists available to assist in development of these resource plans.





SOIL CONSERVATION SERVICE